OF ILLINOIS
DEC 31 1957
MUSEUMS
LIBRARY
DIV. OF HERPETOLOGY

1957, No. 4 December 1

QL
640
C18

Copeia

ESTABLISHED IN 1913

PUBLISHED BY

THE AMERICAN SOCIETY OF

ICHTHYOLOGISTS AND HERPETOLOGISTS

CONTENTS

THE NEOTROPICAL SNAKE GENUS *Nothopsis* COPE. By *Emmett R. Dunn and Herndon G. Dowling*... 255

OBSERVATIONS ON THE BEHAVIOR OF *Draco volans* IN THE PHILIPPINES. By *Nelson G. Hairston*..... 262

VARIATION IN YIELD AND TOXICITY OF VENOM FROM A RATTLESNAKE (*Crotalus atrox*). By *Sherman A. Minton, Jr*..... 265

WARNING BEHAVIOR IN SNAKES OF THE GENUS *Dasypeltis*. By *Carl Gans and Neil D. Richmond*.... 269

MOVEMENTS, AREA OF ACTIVITY, AND GROWTH OF *Rana heckscheri*. By *Keith L. Hansen*..... 274

HIBERNATION, HIBERNACULA AND ASSOCIATED BEHAVIOR OF THE THREE-TOED BOX TURTLE (*Terrapene carolina triunguis*). By *Charles C. Carpenter*..... 278

Alphestes scholanderi, A NEW SEA BASS FROM THE WEST INDIES. By *Vladimir Walters*..... 283

PHASES OF THE LIFE HISTORY OF THE ROSYFACE SHINER, *Notropis rubellus*, IN NORTHWESTERN PENNSYLVANIA. By *Roger J. Reed*..... 286

CHARACTERISTICS AND FERTILITY OF EXPERIMENTALLY PRODUCED SUNFISH HYBRIDS, *Lepomis gibbosus* × *L. macrochirus*. By *Karl F. Lagler and Charles Steinmetz, Jr*..... 290

FILTER PAPER ELECTROPHORESIS OF SERUM PROTEINS FROM SHARKS. By *Theodore J. Starr and Walter Fosberg*..... 292

THE REPRODUCTION AND EARLY DEVELOPMENT OF THE SEA CATFISH, *Galeichthys felis*, IN THE BILOXI (MISSISSIPPI) BAY. By *J. W. Ward*..... 295

ICHTHYOLOGICAL NOTES

Beryx splendens Lowe in the Gulf of Mexico. By *Loren P. Woods*..... 298

Reproductive behavior of *Gambusia heterochir*. By *Barbara Warburton, Clark Hubbs*, and *Donald W. Hagen*..... 299

Occurrence of young dolphin, *Coryphaena hippurus*, in a Texas bay. By *Patricia Pew*..... 300

A record of the night shark, *Hypoprion signatus*, from Bimini, Bahamas. By *Louis A. Krumholz*..... 300

An early review article on the swim bladder of fishes. By *Edward M. Nelson*..... 301

Measurements of a large sharpnose mackerel shark, *Isurus oxyrinchus*, from Bimini, Bahamas. By *Louis A. Krumholz*.... 302

A remarkable instance of parallelism among teleost fishes. By *James W. Atz and Christopher W. Coates*..... 302

Cichlaurus versus *Cichlasoma* as the name for a genus of perciform fishes. By *Reeve M. Bailey*..... 303

Fishes of the family Gempylidae collected by the Bermuda Oceanographic Expeditions 1929, 1930, 1931, and 1934. By *Nancy A. Voss*..... 304

HERPETOLOGICAL NOTES

Observations on hibernation and nests of the collared lizard, *Crotaphytus collaris*. By *John M. Legler and Henry S. Fitch*.. 305

The laminal spurs of the juvenile gopher tortoise, *Gopherus polyphemus* (Daudin). By *Wilfred T. Neill and E. Ross Allen*.. 307

The southern painted turtle in Oklahoma. By *Arthur N. Bragg and William N. Bragg*..... 307

Plethodon cinereus dorsalis in Mississippi. By *William E. Brode*..... 308

Amphibians and reptiles of Glacier National Park, Montana. By *Richard H. Manville*..... 308

Additional specimens of *Trimorphodon vilkinsoni* from Texas. By *William G. Degenhardt and G. Earl Steele*..... 309

Longevity of snakes in captivity in the United States as of January 1, 1957. By *Charles E. Shaw*..... 310

Thyroidless tadpoles of *Pelobates syriacus* Boettger H. By *Dvorah Boschwitz*..... 310

The chorus frog, *Pseudacris nigrita*, at Plattsburgh, New York. By *Robert H. Gibbs, Jr.*..... 311

The status of *Heterodon browni* Stejneger. By *Richard A. Edgren*..... 312

REVIEWS AND COMMENTS..... 313

EDITORIAL NOTES AND NEWS..... 317

INDEX..... 332

Published quarterly by the American Society of Ichthyologists and Herpetologists, 34th St. and Girard Ave., Philadelphia 4, Pa. Second class mail privileges authorized at Philadelphia, Pa. Additional entry at the post office at Baltimore, Maryland.

1957 No. 4 COPEIA December 19

The Neotropical Snake Genus *Nothopsis* Cope

EMMETT R. DUNN[1] AND HERNDON G. DOWLING

THE small snake from Panamá on which Cope (1871: 201) based his new genus *Nothopsis*, and his new species *rugosus* is known from only 17 specimens. Five of these have not been reported, but two of the 11 previously reported specimens were named as new species. All but three of the known specimens have been examined by one or both of us.

Genus *Nothopsis* Cope, 1871

Type species: N. rugosus Cope, 1871, by monotypy

The authors of the more recent names, *affinis* Boulenger and *torresi* Taylor, appear to have seen no more than three specimens of *Nothopsis* at the time of the description of their new forms. Furthermore, the specimens upon which these names were based were not compared directly with the type of *N. rugosus*, but rather were compared with the original description and plate (Cope, 1871: 201–03, pl. 17), parts of which are in error. Examination of 14 specimens, including the type of *N. rugosus*, provides new information on the variation found in this species, and more precise data on the type specimen (USNM 12427) than has been previously available. On the basis of these data we consider all three nominal forms to be conspecific. Further information is given under the specific name.

Nothopsis rugosus Cope

Nothopis rugosus Cope, 1871: 201–03, pl. 17, figs. 1–7 (original description).—Boulenger, 1893: 176 (listed).

Nothopsis affinis Boulenger, 1905: 453 (original description; type locality Salidero, N. W. Ecuador, 350 feet).

Nothopsis rugosus Cope, Dunn and Bailey, 1939: 7 (summary of known localities and a new locality, "ridge at headwaters of west branch of Rio Cuango [Panamá]. . . 700 feet").—Dunn, 1940: 117 (new locality, top of Cerro Campaña, Panamá, *ca.* 3000 feet); 1942: 5–6 (new locality, Farm Two, Chiriqui, Panamá); 1944: 197 (new locality, "en el Choco," Colombia).

Nothopsis torresi Taylor, 1951; 31–34, pl. I (original description; type locality "Morehead" Finca [corrected to "Morehouse" Finca by Taylor, 1954: 683], 5 miles southwest of Turrialba, Costa Rica), 1954: 683–84 (new locality, Turrialba, Costa Rica).

Location of type specimen, and type locality.—USNM 12427, an adult female collected on the Caribbean Coast of the "Isthmus of Darien" by the Panama Canal exploring party under Commander Selfridge.

DESCRIPTION

SPECIMENS EXAMINED.—Colombia, *Distrito Choco*, "Agua Clara" [not located] on the Rio Tamana (ICNB); "Sierra de Baudo, 1000 m." (ANSP 25184).

Costa Rica, *Provincia Heredia*, Cariblanco (BMNH 1905.1.30.51); *Limon*, Reventazon [= La Junta near Siquirres] (MCZ 15269).

Nicaragua, *Departamento San Juan del Norte*, San Juan River (USNM 19562).

Panamá, *Provincia Bocas del Toro*, 11 km. northwest of Almirante, 600 feet (CNHM 78317); near Almirante (CNHM 77602); *Chiriqui*, Farm Two of Chiriqui Land Company, near Puerto Armuelles (ANSP 24250); *Colon*, "Ridge at headwaters of west branch of Rio Cuango . . . 700 feet" (MCZ 47263); "Behind Palenque, Brazo Media del Rio Cuango, 500 feet" (CNHM 77604); *Panamá*, Cerro Campaña, 2600 feet (ANSP 21588); *Veraguas*, La Mesa (CNHM 77603); "*Isthmus of Darien*," Caribbean Coast (USNM 12427, type of *N. rugosus*).

GENERAL.—This snake has a boid appearance because of its distinct head, small eye, and the small scales covering the head and body. The tail is long, averaging about 45 percent of the head-body length in males and about 40 percent in females (Table I). The body is somewhat compressed in appearance and the large head, which makes up about 5 percent of the head-body length, is distinct from the slender neck. The eyes are placed dorsally on the head and have a diameter equal to about 15 percent of the head length. All the specimens are small, the largest

[1] Deceased.

TABLE I

VARIATION IN SNAKES OF THE GENUS *Nothopsis*

	Sex	Max. teeth	Circumorbitals	Rows of temporals	Supralabials	Infralabials	Gulars	Ventrals	Caudals	Dorsals	Body length	Tail length
Nicaragua												
USNM 19562	♀	19+2	16–16	10–10	12–12	14–13	10	152	83	26+28+24	260	102
Costa Rica												
EMNH 1905.1.30.51	♀	—	—	—	—	—	—	156	81	28+28+24	—	—
MCZ 15269	♀	—	—	—	10–10	11–13	—	153	92	26+26+22	—	—
KUMNH 31946*	—	19+2	17–17	—	12–12	13–14	—	153	88	26+28+24	—	—
KUMNH 28719†	—	18[?]	—	8–8	9–10	12–13	—	149	71[+]	26+26+22	284	117[+]
Panamá												
CNHM 78317	♂	—	16–17	9–9	11–10	14–14	11	156	112	28+28+24	136	71
CNHM 77602	♀	—	15–16	9–9	12–11	16–14	12	161	101	28+30+26	187	86
ANSP 24250	—	19+2	15–15	8–9	11–10	13–12	10	—	—	26+—	—	—
CNHM 77603	♂	21+2	23–21	9–10	12–13	15–15	12	155	95	28+28+24	282	124
MCZ 47263	♀	—	—	—	13–13	—	—	161	95	30+30+26	152	61
CNHM 77604	♂	20+2	17–19	9–9	12–12	13–13	12	157	96	26+28+24	300	133
USNM 12427	♀	18+2	—	—	11–12	—	—	158	+	28+30+24	295	85+
ANSP 21588	♂	19+2	17–18	10–10	12–11	13–14	11	153	101	28+28+24	164	74
Colombia												
ICNB	♀	—	—	—	—	—	—	—	—	26+26+24	230	100
ANSP 25184	♂	21+2	15–14	7–8	11–10	13–13	10	162	105	24+26+24	151	71
Ecuador												
BMNH 1946.1.15.-62‡	♀	20	—	—	10–10	—	—	162	98	26+26+22	320	100

* *Fide* Taylor, 1954: 683–84.
† *Fide* Taylor, 1951: 31–34 [Type of *N. torresi*].
‡ *Fide* Boulenger, 1905: 453, and H. W. Parker, *in litt.* [Type of *N. affinis*].

(CNHM 77604), an adult male, has a total length of only 433 mm.

Coloration and pattern.—A series of 31 to 38 pairs of large subtriangular chocolate-brown or black blotches is present dorsolaterally on the body, which has a yellowish or cream-colored ground color. The blunt apices of the triangles fuse to form a single dorsal series of hourglass-shaped blotches when those of one side oppose those of the other, but they usually alternate over a part of the body. The ventral bases of the triangles are usually open, and a large part of this area is occupied by a smaller lateral series of rounded or rhomboid spots. The pattern is continued on the tail in a reduced fashion and usually fades out entirely anterior to the tip of the tail. This pattern was compared with that of *Bothrops atrox* by Cope, and is an unusual one for a colubrid snake (*vide* Cope, 1871: pl. 17; Taylor, 1951: pl. 1). The head is generally uniform brown or black, the labials somewhat lighter brown or tan, and the chin and gulars yellowish or cream-colored. The ventrals are yellowish or cream-colored and are irregularly stippled and streaked with brown.

Scutellation.—The head is largely covered with small scales and most of the usual colubrid scutes are broken up to some degree. The two subtriangular internasals are complete and in contact with one another, and narrowly separate the nasals. The prefrontals are broken into three to five rows of small keeled scales (30–60 in number), but in some specimens a few of the anteriormost scales are larger than the remainder and lack keels. The frontal is usually divided, at least to some degree, by a median longitudinal suture which also may be invaded by small scales; the lateral edges are usually irregular and broken. The parietals are separated from one another and from the frontal by one to three rows of small scales.

The nostril is large and is situated in a single large nasal which is longer than the diameter of the eye and which is partly divided

Plate I. Hemipenis of *Nothopsis rugosus* Cope. The tiny spinules of the basal part grade into small papillate calyces just proximal to the fork of the sulcus. The lateral separation of the spines from the sulcus is unusual. The two folds near the distal end apparently indicate a bilobed condition of the organ when everted. [Drawn from the retracted organ of CNHM 77604 which was split along its median side and spread flat. Drawing by Miss Esther Coogle.]

by a suture extending from the nostril down to the junction of the first and second supralabials. The loreal area is occupied by five to ten smooth scales that are larger than the dorsals. The eye has a round pupil and is surrounded with a ring of about 16 scales, of which one or two "preoculars," two or three "supraoculars," and two or three "postoculars" may be slightly enlarged. A lorilabial row of small scales begins under the loreal region and extends under the eye giving two rows of scales between the ocular and the supralabials except where one of the rows is interrupted. The temporal region is covered with seven to ten rows of scales that are similar to the dorsals in size and appearance. The supralabials have a mean of about 11, and the infralabials have a mean of about 13 (Table I).

The first infralabials are in contact with one another behind the mental and are followed by the single pair of genials. The latter are separated from one another by a row of small scales, and from the first ventral (as defined by Dowling, 1951) by about ten rows of gulars. One to three gulars just anterior to the ventrals may be somewhat enlarged and may have been counted as "ventrals" by previous workers. The ventrals are sculptured with very fine striae along their outer edges and vary in number from 149 (type of *N. torresi*) to 162, without any sexual dimorphism apparent. The caudals vary from 81 to 101 pairs in six females, and from 95 to 112 pairs in five males. The count of 71 reported for the type of *N. torresi* (Taylor, 1951: 33) is believed incomplete since the "terminal spine of tail [is] directed somewhat down at tip and partly scaled dorsally," a condition not found in specimens with complete tails.

The dorsal scales are small and heavily keeled, distinctly sculptured, and without apical pits. The vertebral (middorsal) row drops out or fuses with an adjacent row eight to ten scales behind the parietals (at the level of the first to third ventral), giving an even number of scale rows over most of the body. A typical scale formula (CNHM 77604) is:

$$31\ \frac{}{15+16\ (2)}\ 30\ \frac{-7\ (8)}{7+8\ (6)}\ 28\ \frac{-7\ (23)}{-7\ (23)}\ 26\ \frac{+7\ (26)}{+7\ (26)}\ 28\ [i]\ \frac{6+7\ (97)}{6+7\ (102)}\ 26\ \frac{-6\ (136)}{-6\ (130)}\ 24\ (157).$$

The middorsal row is consistently missing in the specimens examined but, as indicated by the "*i*" in the formula above, the seventh row may be lost in an irregular fashion for short distances (2–4 scales) on one or both sides, thus occasionally giving odd-numbered counts in this way. Also, as indicated by Taylor (1951: 34), the paravertebral (median) rows may occasionally fuse, giving odd-numbered counts. The scale counts vary from 24 + 26 + 22 in almost every combination to 30 + 30 + 26.

It should be pointed out that the plate accompanying the original description of *N. rugosus* (Cope, 1871: pl. 17) is in error in several items of scutellation, as demonstrated by examination of the type. The nostril and nasal plates are completely omitted from the lateral view (*ibid*: fig. 2), and the two halves of the frontal are shown completely separated (*ibid*: fig. 3) by a row of small scales, while actually [as Cope mentions in the text (*ibid*: 203)] they are not so separated.

Hemipenis.—The hemipenis has never been described for this genus, and until recently no adult males were known. The following description is based on study of two adult males collected in Panamá in 1952 (CNHM 77603–04).

The hemipenis extends to caudal XI. The organ is moderately bilobed and the sulcus forks at caudal VI (Plate I). The basal half is covered with tiny spinules near the sulcus, but just proximal to the fork of the sulcus they are reduced in size and joined with membranes to form small (less than 1 mm. in diameter) papillate calyculae that extend along and between the sulci to the tip of the organ. Lateral to this area (opposite the sulcus if everted) a patch of about 20 large (2–3 mm.) spines lies just proximal to the fork, and extends distally as paired series of somewhat smaller (1–2 mm.) spines along the outer edge of each lobe to near the tip.

Dentition.—The maxillary teeth vary in number from 17+2 (*fide* Taylor, 1951: 33) to 21+2, the usual number being 19+2 (Table I). The count of 12 for the type of *Nothopsis rugosus* reported by Taylor (1951: 33–34) was no doubt obtained by counting the teeth figured on the plate accompanying the original description (Cope, 1871: pl. 17, fig. 5), or from

Boulenger (1893: 176), who must have obtained it in this way.

Examination of the type specimen (USNM 12427) shows the plate to be in error here also. The posterior end of the left maxillary bone is broken off in the type. The teeth actually present may have been twelve, but a count of the sockets as well gives a total of 18 for this part of the bone. The other maxillary is complete and shows a normal complement (18+2) of teeth.

A full tooth count of a stained and cleared head of *Nothopsis* was made for us by Charles M. Bogert. In this specimen the maxillary teeth are 20+2 and 20+2, teeth anterior to diastema decreasing in size posteriorly; palatine teeth 11−10 and pterygoid teeth 27−27, the palato-pterygoid series decreasing in length posteriorly with the last pterygoid tooth about one-half the size of the first palatine tooth; dentary teeth 32−31, decreasing in length posteriorly but with the anterior two or three teeth somewhat shortened.

Skeleton.—Hypopophyses are found on all dorsal vertebrae. As previously pointed out (Dunn, 1942: 6), "The vertebrae have the neural spines expanded, flattened, and divided by a longitudinal groove."

The form of the postfrontal bone in this snake was used by Cope in his allocation of this genus. It is interesting, therefore, that under good lighting the "postfrontal . . . process, as far [forward] as the prefrontal," (Cope, 1871: 202) and the "only faint traces of 'independent supraocular bones,' " (Dunn, 1942: 6) becomes merely, "a row of foramina . . . [with] no evidence of a suture," (Bogert, *in litt.*).

Variation.—It is difficult to separate geographic from individual variation in a series of this size since the specimens are from such widely scattered localities. The variation of labials, dorsals, and body proportions gives no indication of geographic influence.

The number of ventral scutes appears to increase toward the south—the two southernmost specimens (from Colombia and Ecuador) each have 162 ventrals—whereas the northernmost five specimens range from 149 (*fide* Taylor, 1951: 31) to 156. Specimens from Panamá, which make up the major part of those available, closely approach both extremes, however; seven specimens range from 153 to 161 (Table I). Thus, differences, if real, appear to be more clinal than an indication of the semi-isolation that would be characteristic of subspecific status.

Sexual dimorphism is apparent in tail length and in the number of caudals. The tail proportions (in percent of body length) range from 44 to 51 percent in five males, and from 39 to 46 percent in four females. Similarly the caudals in five males range from 95 to 112, with a mean of about 102. The caudals in six females range from 81 to 101 with a mean of about 93.

Ontogenetic variation is also suggested in the tail proportions. The smallest male (body length of 136 mm.) has proportionately the longest tail (51 percent) and the two adult males (body lengths of 282 and 300 mm.) have the shortest (44 percent) for their sex. The intermediate specimens show the same trend (Table I), as do the females.

Natural History.—There is little information on the natural history of this rare snake. There are specific remarks on habits and habitat for three individuals.

The specimen from the west branch of the Rio Cuango (MCZ 47623) was captured on a ridge at an altitude of 700 feet. Its stomach contained a specimen of *Oedipina parvipes*, a common salamander of the forest floor.

The specimen from Cerro Campaña (ANSP 21588) was taken at an altitude of about 2600 feet by Dr. Graham Fairchild, with Dunn present (Dunn's field notebook for July 2, 1939). It was on the floor of the damp forest that covers this peak from about 2500 feet to the top (*ca.* 3200 feet). This capping forest is now isolated by grasslands and cliffs, but probably once extended down to the coast at the Chame Peninsula.

The specimen from southwest of Turrialba (KUMNH 28719) was taken (*fide* Taylor, 1951: 34) "at night . . . in a pile of leaves on the ground, near the edge of a swampy area in the forest. The specimen made no attempt to bite."

The dorsally-placed eyes, compressed body, and general habitus of *Nothopsis* suggest an aquatic snake as did Cope's original suggestion (1871: 202) that its relations are with the watersnakes of southeastern Asia (*Acrochordus, et al.*). The present information suggests that it is, instead, a terrestrial and perhaps nocturnal snake of the tropical rainforest.

Range.—The known geographic range of this

species extends from the San Juan River, Nicaragua, southward through Costa Rica, Panamá, and the Choco of Colombia, to "Salidero," Ecuador. The reported altitudinal range is from near sea level (Puerto Armuelles; San Juan River) to about 1,000 meters (Sierro Baudo).

Taxonomic Discussion

The unusual appearance of *Nothopsis* has prevented its confusion with other snakes, and its allocation to other genera. Nevertheless, the 17 known specimens have led to a considerable number of taxonomic opinions.

Nominal species.—Some years after the description of *Nothopsis rugosus* Cope (1871), from Panamá, Boulenger (1905: 453) described *N. affinis* from Ecuador (type, original number BMNH 1902.8.33, now BMNH 1946.1.15.62). He had only one other specimen (BMNH 1905.1.30.51, from Costa Rica) available for comparison. The main differences noted were, "in the feebly keeled scales, the presence of a pair of praefrontal shields, the larger frontal and parietals, and the more feebly angulate ventral shields."

The appearance of the keeling in snake scales is heavily influenced by the strength of the preservative in which the specimen is placed. We are unable to observe any consistent differences in this feature or the angulation of the ventral scutes between the southern specimens and the northern ones. Also, as indicated in the previous descriptive section, there is a great deal of variation in the number of scales in the prefrontal region and in the size and shape of the remaining head scutes. Most of the specimens have one or more smooth and enlarged scales in the prefrontal area, scales which are more than twice the size of the dorsal scales. A snake with two such enlarged scales might be said to have "prefrontals." This situation was noted in one snake from Colombia (ANSP 25184), two from Panamá (ANSP 24250, CNHM 78317), and one from Nicaragua (US NM 19562). These snakes differed in no important way from the type of *N. rugosus*. Thus, since the presence of "prefrontal" scales is not correlated with any other morphological difference and since their presence is restricted to no geographic area, we consider *N. affinis* Boulenger (1905) to be a strict synonym of *N. rugosus* Cope (1871).

Recently Taylor (1951: 31) has described a specimen from Costa Rica (KUMNH 28710) as a new species, *N. torresi*. This form was distinguished from *N. rugosus*, "by the presence of an even or odd number of scale rows; the reduction of the scales about the middle of the body and the increase in the number of maxillary teeth, approximately 18 instead of 12," (*ibid:* 33). His comparative material consisted of one other snake from Costa Rica (MCZ 15269), which was referred "with a question" to *N. torresi* and one from Panamá (presumably MCZ 47263) which he referred to *N. rugosus*. In his tabular presentation (*ibid:* 34) Taylor indicates other apparent differences, showing *N. torresi* to have fewer ventrals, subcaudals and dorsal scale rows.

The greatest apparent difference between *N. torresi* and *N. rugosus*, that of the number of maxillary teeth, is based on erroneous data. As indicated in the descriptive section, the plate accompanying the original description (Cope, 1871: pl. 17) is inaccurate on this point. There actually are 18+2 teeth rather than the "12" on which Taylor based his diagnosis. Taylor (1954: 683) has recently tentatively allocated another specimen (KUMNH 31946) from Costa Rica to *N. torresi*. This specimen has 28 scale rows, thus breaking down the presumed difference in dorsal row number between the nominal forms. As indicated above, the irregular loss and addition of scale rows may give "even or odd numbers of scale rows," and it may be added that workers may not agree on the number on a single specimen. Thus Taylor (1951: 34) found a midbody count of 28(29) on a specimen recorded as 30 by us, and Parker (*in litt.*) counted 26 on the type of *N. affinis*, which was recorded as 27 by Boulenger (1905: 453). Our larger series of snakes shows overlapping counts for the Costa Rican and Panamanian snakes in both ventrals and dorsals. The subcaudals approach closely, and would no doubt overlap except for the fact that most of the Panamanian snakes are males, whereas the northern ones that are available are females. No other differences are evident. *Nothopsis torresi* Taylor (1951) is relegated, therefore, to the synonymy of *N. rugosus* Cope.

Definition of the genus Nothopsis.—A genus of colubrid snakes with hypopophyses in the posterior part of the vertebral column, vertebrae with expanded neural spines and prezyga-

pophyses; dentition diacrantarian, about 19 teeth anterior to diastema, two slightly enlarged ungrooved teeth posterior to it; hemipenis single, spinose proximally and calyculate distally, sulcus forked; head scutes reduced and invaded by small scales; a single pair of genials; ventrals present, of normal width; anal plate entire; subcaudals paired; dorsal scales keeled, without apical pits, in 25 to 30, usually even-numbered rows, usually being reduced by loss of the seventh scale row.

Generic relations.—Cope (1871: 202) originally proposed a separate family for *Nothopsis*, the Nothopidae. He suggested that this family was near the Acrochordidae and that the genus *Xenodermus* Reinhardt might also belong here. He retained this allocation in his "Analytical Table" (1886: 484), but Boulenger (1893: 172) placed these two genera and the watersnakes of southeastern Asia in the subfamily Acrochordinae of his much more comprehensive family Colubridae. Cope (1896: 199) again removed this assemblage from the Colubridae as the family Acrochordidae, recognizing in it the subfamily Nothopinae. Later (1900: 731) he revived the familial name Nothopidae for these snakes, recognizing the two subfamilies Acrochordinae and Nothopinae.

More recently Malcolm Smith (1943: 123) placed *Nothopsis* (by implication) together with four genera of southeastern Asia in the Xenoderminae, erroneously attributing this name to Cope (1900: 731). Taylor, (1951: 30), however, followed Boulenger in his use of the name Acrochordinae, while Schmidt (1950: 83) and Romer (1956: 583) followed Smith's use of the name Xenoderminae.

These changes are mainly nomenclatural since in each, *Nothopsis* is closely associated with the genus *Acrochordus* Hornstedt, and included in a division with the genera *Xenodermus* Reinhardt and *Stoliczkaia* Jerdon (Cope, 1900: 731), with the genera *Achalinus* Peters and *Fimbrios* Smith, recently added (Smith, 1943: 123). All these other genera are found in southeastern Asia, and the allocation of *Nothopsis* to this group is based primarily on Cope's original statement that the postfrontal bone extends forward to contact the prefrontal—a statement now known to be erroneous. There is, therefore, no real indication of relationship between *Nothopsis* and these other genera.

Some years ago it was pointed out (Dunn, 1942: 6) that *Nothopsis* has "the neural spines expanded, flattened, and divided by a longitudinal groove," as in the "otherwise very dissimilar South American snake *Xenopholis*." Romer (1956: 583) recently added this latter genus to the "Xenoderminae," apparently on the basis of this unusual resemblance. However, this condition has also been described in the equally (and differently) dissimilar genus *Cercaspis* Wagler of southeastern Asia (Wall, 1921: 404), and in the superficially similar *Xenodermus* of the same region (Smith, 1943: 123). These three genera differ greatly in scutellation and dentition, and *Nothopsis* differs from *Cercaspis* in hemipenial characters as well (this organ does not appear to have been described for *Xenodermus* or *Xenopholis*).

Nothopsis has the prezygapophyses of the vertebrae expanded, as does *Cercaspis*. *Xenopholis* has both pre- and post-zygapophyses expanded, particularly the latter, and this is apparently also true in *Xenodermus* and *Stoliczkaia* which are described by Smith (1943: 123) as having the "zygapophyses" expanded. That this character may appear in unrelated groups is demonstrated by its appearance in the elapid genus *Bungarus* Daudin (Smith, 1943: 412). Thus neither the expanded neural spine nor the expanded zygopophyses are considered reliable indicators of relationship.

The characters of the hypopophyses in the posterior part of the vertebral column, enlarged posterior teeth, absence of scale pits, lack of normal complement of head shields, and forked sulcus of the hemipenis together indicate allocation of *Nothopsis* to the "xenodontine" colubrids (=Ophiinae, Dunn, 1928: 20) and place it in the same (perhaps artificial) group with the American genera *Helicops*, *Amastridium*, *Diaphorolepis*, and *Synophis* (*ibid:* 24). Charles M. Bogert is now studying the relations of the last two genera and illumination of these suggested relations are to be expected. In any case *Nothopsis* differs from these snakes in many characters, and remains a distinct genus without apparent close relatives.

ACKNOWLEDGMENT

We express our thanks to the following persons and institutions for making specimens or data available: Charles M. Bogert, American

Museum of Natural History (AMNH); H. W. Parker, British Museum (Natural History) (BMNH); Harold Trapido, Gorgas Memorial Laboratory, Panamá; Arthur Loveridge, Museum of Comparative Zoology (MCZ); Doris M. Cochran, U. S. National Museum (USNM); and to the authorities of the Academy of Natural Sciences of Philadelphia (ANSP) and the Instituto de Ciencas Naturales, Bogotá, Colombia (ICNB).

The junior author would like to express thanks to Robert F. Inger, Chicago Natural History Museum (CNHM) for the loan of specimens deposited in that institution and to Charles M. Bogert, William J. Riemer, and Karl P. Schmidt for reading the manuscript. The opportunity for preparation of this final revision was provided by a University of Florida Postdoctoral Fellowship, for which I am especially grateful.

Summary

Fourteen of the seventeen known specimens of *Nothopsis* were studied and the variation in body proportions and scutellation are described. The hemipenis is described for the first time. Natural history information indicates *Nothopsis* to be a terrestrial snake of the tropical rainforest. It is known from Nicaragua to Ecuador at elevations from near sea level to about 1000 meters. The nominal forms *N. affinis* Boulenger (1905) and *N. torresi* Taylor (1951) are placed in the synonymy of *N. rugosus* Cope (1871), making *Nothopsis* a monotypic genus. The genus is defined, and it is indicated that its supposed relationships with snakes of southeastern Asia rest upon erroneous morphological information. Its relations with other genera are obscure, but it appears to be a somewhat atypical xenodontine colubrid whose relatives are probably to be found in the American tropics.

Literature Cited

Boulenger, George A. 1893. Catalogue of the Snakes in the British Museum (Natural History). Vol. I. London, Taylor and Francis: xiii + 448 pp., 28 pls.

———. 1905. Descriptions of new snakes in the collection of the British Museum. *Ann. Mag. Nat. Hist.*, Ser. 7, *15:* 453–56.

Cope, Edward D. 1871 Ninth contribution to the herpetology of Tropical America. *Proc. Acad. Nat. Sci. Phila., 23:* 200–24, pl. 17.

———. 1886. An analytical table of the genera of snakes. *Proc. Amer. Philos. Soc., 23:* 479–99.

———. 1896. The classification of the Ophidia *Trans. Amer. Philos. Soc.* (N. S.) 18, art. 3: 186–219. pls. 14–33.

———. 1900. The crocodilians, lizards and snakes of North America. *Ann. Rept. U. S. Natl. Mus. for* 1898: 153–1270, 36 pls.

Dowling, Herndon G. 1951. A proposed standard system of counting ventrals in snakes. *British Jour. Herp., 1* (5): 97–99.

Dunn, Emmett R. 1928. A tentative key and arrangement of the american genera of Colubridae. *Bull. Antiven. Inst. Amer., 2* (1): 18–24.

———. 1940. New and noteworthy herpetological material from Panama. *Proc. Acad. Nat. Sci. Phila., 92:* 105–22, p.l 2.

Dunn, Emmett R. 1942. New or Noteworthy Snakes from Panama. *Notulae Naturae, (108):* 8 pp.

———. 1944. Los Generos de Amphibios y Reptiles de Colombia. III. Reptiles; Orden de las Serpientes. *Caldasia, 3* (12): 155–224.

———. and Joseph R. Bailey. 1939. Snakes from the Uplands of the Canal Zone and of Darien. *Bull. Mus. Comp. Zool., 86* (1): 1–22.

Romer, Alfred S. 1956. Osteology of the Reptiles. Chicago, Chicago Press: xxi + 772 pp., 248 figs.

Schmidt, Karl P. 1950. Modes of Evolution Discernible in the Taxonomy of Snakes. *Evol., 4* (1): 79–86.

Smith, Malcolm A. 1943. Reptilia and Amphibia. Vol. III. Serpentes. *In* Sewell, R. B. S. The Fauna of British India. . . . London, Taylor and Francis: xii + 583 pp., 166 text figs., map.

Taylor, Edward H. 1951. A Brief Review of the Snakes of Costa Rica. *Univ. Kansas Sci. Bull.*, 34, pt. I (1): 3–188, 23 pls., 7 text figs.

———. 1954. Further Studies on the Serpents of Costa Rica. *Univ. Kansas Sci. Bull.*, 36, pt. *2* (11): 673–801, 40 figs.

Department of Biology, Haverford College, Haverford, Pennsylvania; Department of Zoology, University of Arkansas, Fayetteville, Arkansas.

Observations on the Behavior of *Draco volans* in the Philippines

NELSON G. HAIRSTON

FLYING lizards are among the most conspicuous members of the herpetofauna of Leyte. A number of observations were made on their activity and behavior during the years 1954–1956. I wish to thank Mr. G. Dancel of the Philippine Department of Health for the gift of a specimen which agrees in all observable detail with those photographed. This specimen has been identified as *Draco volans* L. by Dr. R. F. Inger of the Chicago Natural History Museum. I am also grateful to Dr. N. E. Hartweg and Dr. C. F. Walker of the Museum of Zoology, University of Michigan, for references and editorial comments.

HISTORICAL

References to the habits of *Draco* are scattered and, like those reported here, the observations were made incidental to other activities. Although authors (Mertens, 1930; Williams, 1934; Smith, 1935; McCann, 1940) have reported various aspects of display, especially the movement of the gular appendage, only Schmidt (1935) related these activities to modern behavioral theory. Cantor (1847) examined the digestive tract of *D. maculatus* and found the diet to consist primarily of ants, an observation that has been confirmed (Mertens, 1930; Taylor, 1922).

There are apparently no photographs in the literature of *Draco* in its natural habitat. The excellent pictures taken by Stackpole (see Tweedie, 1956) are of captive specimens, and the photograph published in conjunction with Leiker (1953) is evidently of preserved material, as the log on which they are placed is apparently from a tree (birch) which does not occur in the Oriental Region, and the claws of the male are not gripping the surface. Moreover, the article states that he did not find flying lizards in New Guinea. Other published photographs are even more obviously of preserved specimens.

GLIDING

At least two authors (Pope, in Schmidt, 1927; Gray, 1953) have expressed doubts about the gliding ability of *Draco*, but they did not see them in the field. *Draco volans* is an accomplished glider. Ten flights ranged from 4.5 to 12 meters, and averaged 8 meters in length. The distances were doubtless conditioned by the fact that coconut trees are ordinarily planted 8–10 meters apart. Mertens (1930) recorded flights of 15 to 20 meters, and no doubt longer ones are possible, although a habitat in which such flights were necessary would probably be unattractive to the species.

In two observations the angle of the glide was estimated. For the first, the estimate was between 20° and 30° from horizontal; for the second, the starting and ending heights were estimated as 6 meters and 3 meters, respectively, and the horizontal distance measured 7.6 meters. Thus, the angle is close to 22°, and is in agreement with the more subjective first estimate. *Draco* would therefore qualify as a gliding animal by the definition of Oliver (1951), who distinguishes "gliding" from "parachuting" when the angle is greater than 45° from vertical. The flight appeared rather slow, as though being maintained at close to the stalling point, an observation that agrees with the slight amount of upturn at the end of the glide (see also Schmidt, 1935, on *D. spilopterus*).

McCann (1940) suggested that the main gular appendage is used as a rudder. Stackpole's photograph, however, shows it held flat, although the lateral folds are spread. I saw no individual extend the gular appendage in flight, and all flights started with it retracted.

A flying lizard preparing to glide is easily recognizable by its habit of turning around to face head-downwards. The only other situation in which an individual was seen headed down the tree was during courtship display. *Draco* does not use its gliding ability to escape from a human observer. It always climbs when disturbed, even when sticks or stones are thrown at it, an observation also made by Mertens (1930) and Beebe (see Tweedie, 1956). Beebe, however, watched one escape from a climbing monkey by gliding.

PERIODICITY

Draco was seen either gliding or displaying as early as 7:45 AM and as late as 4:30 PM, and

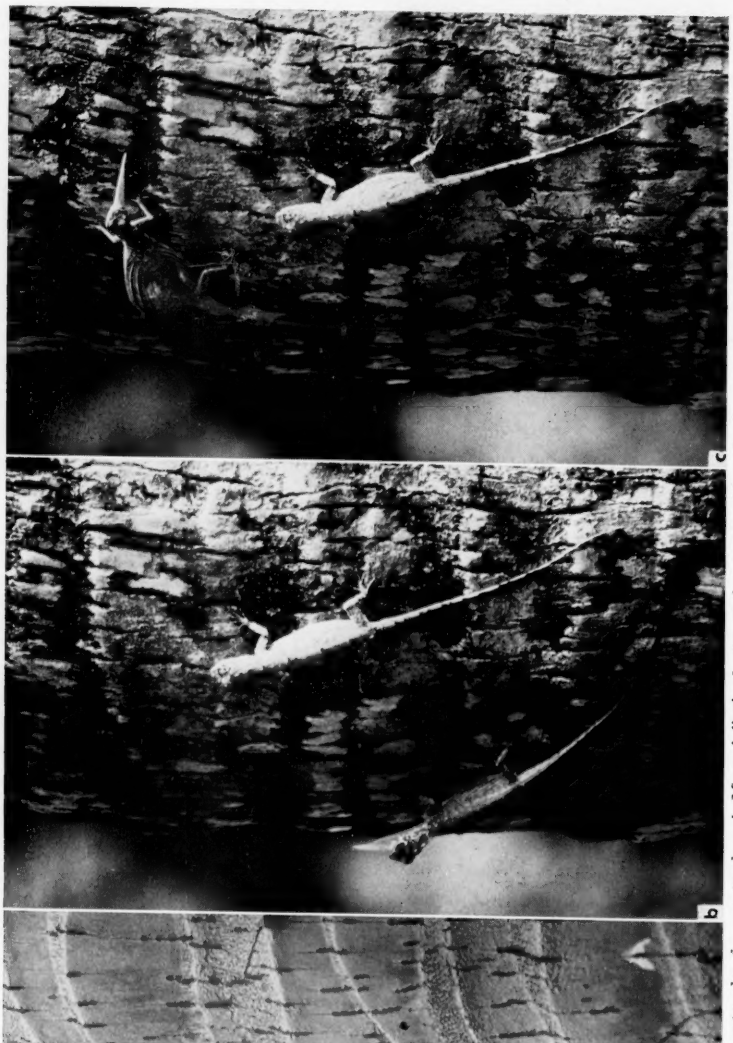


Plate I. *Draco volans* on trunks of coconut palms. A. Mutual display by two males; note position of gular appendage and erection of nuchal area. B. Male displaying before female; note ribs in wing and absence of erection of nuchal area. C. Maximal stage of display photographed; in full display, wings are completely open. Female in identical position held in B.

I was reliably informed of at least one occasion of late afternoon (5:00–6:00 PM) activity. The peak of activity comes in mid-morning. Sixteen of 31 records were made between 8:00 and 11:00 AM. *Draco* thus appears to be definitely diurnal, as reported by Bogert (1954). On several occasions when other night studies were being made in known habitats of this lizard, none could be found in the accustomed places, though the trees were searched with strong lights.

There is evidence of an interruption of activity around noon. That this is not merely a reflection of the observer's lunch hour was shown in a continuous series of observations from 8:00 AM to 3:00 PM. The inactive period lasted from 10:53 AM until 12:55 PM. On other occasions, active individuals were seen as late as 11:15 AM. All together, my observations indicate an inactive period of about an hour and a half, centered at about noon. The inactivity thus appears to be more nearly related to light intensity than to temperature, since activity is resumed before the time of the daily temperature maximum. The pattern of activity is somewhat similar to that reported for *Sceloporus graciosus gracilis* by Stebbins (1944), and for desert species generally by Smith (1946). It is difficult to visualize a cause for the noon interruption in *Draco*, as flying lizards are normally situated on the vertical trunks of trees. This position would appear to cause them to receive less radiation at noon than they receive earlier or later.

On nearly every occasion when individuals being watched disappeared, they were near the top of the tree, from which I conclude that they rest among the fronds which diverge from the tip of the trunk.

Draco was never seen flying or displaying during rains or strong winds, but perhaps not enough attempts were made to observe it during such conditions; however, Schmidt (1935) recorded similar observations.

Display

The display behavior of *Draco* has attracted more attention than any other habit. Many authors (McCann, Williams, Smith, Mertens, Bogert, Schmidt) have commented on the movements of the gular appendage, and Schmidt speculates on the possibility that the wings originated as a secondary sex character.

In the present observations, seven of nine males seen displaying were near at least one other individual, and three of four males not seen to display were alone. The presence of another flying lizard thus appears to stimulate display. The exceptions, two individuals seen displaying alone, and one pair in which no display was seen, most likely represent incomplete observations; that is, the displaying males may have seen other individuals unnoticed by me, and the pair might have temporarily interrupted display during the rather brief period of observation.

The regularity with which display occurs when two or more flying lizards come together suggests that it is virtually an automatic response, presumably to the sight of another individual, as presence on the same tree is not necessary, and other stimuli appear unlikely.

The sequence of acts performed during display is quite constant. A description of them follows.

1. The extension of the gular fold to a point where its leading edge is perpendicular to the jaw is the first action taken by a male draco. It may be held in this position, or the action may be repeated in a flicking motion. The effect (Pl. I, a) is to make the head appear much larger, and McCann refers to this position as a threatening one and adds that in *D. dussumieri* the mouth is also opened. The two males in the figure have also raised the whole nuchal region more than the rather insignificant nuchal crest would account for. As this was not noticed until the photographs were developed, I have no notes on when it was done, but when the object of display was a female, the nuchal area was not raised (Pl. I, b and c). *Anolis* exhibits a similar distention of the nuchal area (Noble and Bradley, 1933). This increase in the apparent size is similar to display activity in other lizards, and is very much like the reaction of *Corythophanes cristatus* to a presumably frightening object (Davis, 1953).

2. To the opening of the gular fold and the raising of the nuchal area, there is usually added a partial unfolding of the wings, although in one display this was delayed until after the next action.

3. The bobbing action so characteristic of lizard display is a rather prominent feature in *Draco*. Apparently this action, which is accom-

plished by repeatedly bending and straightening the forelegs, represents the peak of display against another male, as subsequent stages were only seen when a female was present. Bobbing never preceded the partial extension of the gular fold, and in only one display did the male fail to open his wings prior to bobbing.

4. The next action apparently depends upon the presence of a female, as it was not seen in four male-to-male displays, but was observed in three of four cases when the male was displaying before a female. In this phase, the gular fold is extended about as far forward as is physically possible (Pl. I, b and c), giving the animal the appearance of possessing a beak. It was evidently this forward projection of the gular fold that led Williams (1934) to suppose that the tongue was being extended, until he observed the action more closely. The maximum extension of the gular fold is accompanied by complete opening of the wings. The wings are shown only partly open in Plate I, c; the only photograph obtained with the wings completely open was not clear enough to be reproduced.

5. In a single case (the one photographed), the male circled completely around the female three times after reaching the maximal display condition. Probably this phase only develops when the female remains still. The photographs show how little she moved during this activity on the part of the male.

Copulation was not observed, but up through the circling by the male, the female remained completely passive in all instances except one, when she was evidently trying to escape.

I made a single observation on the reaction of a male *Draco* to another species of lizard, a green skink, probably *Dasia smaragdina*. Both were on the same tree, the skink climbing down and the draco climbing up. When they were about one meter away from each other, the draco extended his gular fold and continued up the tree, but in a direction that took him past rather than directly towards the other lizard. He showed no other display activity. It cannot be concluded that the display was necessarily directed at the skink, as there was another male flying lizard displaying on a tree 6½ meters away, and a few minutes later both dracos flew to a third tree and went through the display shown in Plate I, a.

Although the foregoing description represents the facts accurately, it will be obvious to the reader that the sequence in which they are presented implies an interpretation. The implication is that display consists of a single series of actions, and that completion of the series depends upon the passivity of the partner. Thus, the beginning of the display evokes a similar series of actions in a male partner, and this response prevents any further development of display behavior, the encounter terminating in the departure of one member, or occasionally in a fight such as the one described by Schmidt (1935). A female flying lizard, by not responding actively to the early phases of display, permits the remaining phases to develop. It is not known whether copulation is preceded by some kind of receptive behavior by the female, such as that shown by *Anolis* (Noble and Greenberg, 1941) or *Leiocephalus* (Noble and Bradley, 1933; Evans, 1953). If the foregoing interpretation is correct, sex discrimination is a function of the male, and depends upon the presence or absence of an active response, as described by Noble and Bradley, who found that males of several different genera could not distinguish between females and passive members of their own sex.

The complexity and distinctiveness of the phases of display that follow identification of the partner as a female indicate that these phases are significant, and their very existence is contrary to the thesis developed by Noble and Bradley that ". . . female choice has played no part in the genesis of male adornment." (op. cit., p. 87). It would seem, on the other hand, that the form and color of the gular fold and wings could be influenced by their effect on both males and females in the process of "sexual selection".

Summary

During the years 1954–1956, a number of observations were made on *Draco volans* on the island of Leyte, Philippines. The lizard was seen to glide as far as 12 meters, and ten flights averaged 8 meters in length, the angle of glide being rather low (estimated at 20°–30° from horizontal). The gular appendage is not used in flight.

Draco is diurnal and shows two peaks of activity daily, one in midmorning, and a lower one in mid-afternoon. The cause for the noon low in activity was not discovered.

Most of the observations were made on male

display, which appears to be an automatic consequence of the sight of another flying lizard of either sex. The sequence of actions involves: 1, partial extension of the gular fold; 2, partial opening of wings; 3, bobbing with the forelegs; 4, complete extension of the gular fold and wings so that the former projects in front of the head; 5, circling around the female. Photographs of several of these are presented. A male response, which involves the same behavior, stops the display at the point of bobbing. The remaining steps depend upon passivity by the partner. Females were not observed to take any active part in display, but may do so before copulation, which was not observed.

It would appear from the evidence that sexual selection could operate upon the gular appendage and wings through their effect on either sex.

Literature Cited

Bogert, C. M. 1954. Amphibians and reptiles of the world. in Drimmer, F. The animal kingdom. *Doubleday, Garden City, N. Y. xl + 2062.*

Cantor, Th. 1847. Catalogue of reptiles inhabiting the Malayan Peninsula and Islands, collected or observed by Theodore Cantor, Esq., M.D. *Jour. Asiatic Soc. Bengal 16 (Part 2): 607–56; 896–951; 1026–1078.*

Davis, D. D. 1953. Behavior of *Corythophanes cristatus. Fieldiana Zoology 35: 1–8.*

Evans, L. T. 1953. Tail display in an Iguanid Lizard, *Leiocephalus carinatus coryi.* Copeia *(1): 50–54.*

Gray, J. 1953. How animals move. *Cambridge, University Press. xii + 114.*

Leiker, D. L. 1953. Hagedissen van Nieuw-Guinea. *Lacerta 11: 37–40.*

McCann, C. 1940. A reptile and amphibian miscellaney, Parts I & II. *Jour. Bombay Nat. Hist. Soc. 41: 742–64; 42: 44–64.*

Mertens, R. 1930. Die Amphibien und Reptilien der Inseln Bali, Lombok, Sumbawa, und Flores (Beiträge zur Fauna der Kleinen Sunda-Inseln I) *Abh. Senckenb. Nat. Gesell. 42: 117–342.*

Noble, G. K. and H. T. Bradley. 1933. The mating behavior of lizards: Its bearing on the theory of sexual selection. *Ann. N. Y. Acad. Sci. 35: 25–100.*

Noble, G. K. and B. Greenberg. 1941. Effects of seasons, castration, and crystalline sex hormones upon the urogenital system and sexual behavior in the lizard (*Anolis carolinensis*) I. The adult female. *Jour. Exp. Zool. 88: 451–79.*

Oliver, J. A. 1951. "Gliding" in amphibians and reptiles, with a remark on an arborial adaptation in the lizard, *Anolis carolinensis carolinensis* Voigt. *Amer. Nat. 85: 171–76.*

Schmidt, K. P. 1927. The reptiles of Hainan. *Bull. Amer. Mus. Nat. Hist. 54: 395–465.*

———. 1935. Notes on the breeding behavior of lizards. *Zool. Series Field Mus. Nat. Hist. 20: 71–6.*

Smith, H. M. 1946. Handbook of lizards. *Comstock, Ithaca, N. Y. xxi + 557.*

Smith, M. A. 1935. Fauna of British India. Reptilia and Amphibia (vol. II, Sauria). *Taylor and Francis, London. xiii + 440.*

Stebbins, R. C. 1944. Field notes on a lizard, the Mountain Swift, with special reference to territorial behavior. *Ecology 25: 233–45.*

Taylor, E. H. 1922. The lizards of the Philippine Islands. *Bureau of Printing, Manila. 1–269.*

Tweedie, M. W. F. 1956. "Flying" reptiles. *Animal Kingdom (Mag. N. Y. Zool. Soc.) 59: 11–15.*

Williams, J. 1934. Notes on the Indian Monitor (*V. monitor*) and the flying lizard (*Draco maculatus*). *Jour. Bombay Nat. Hist. Soc. 37: 739–40.*

Department of Zoology, University of Michigan, Ann Arbor, Michigan.

Variation in Yield and Toxicity of Venom from a Rattlesnake (*Crotalus atrox*)

Sherman A. Minton Jr.

There are few reports of repeated venom extractions from single snakes or groups of snakes. Fairly and Splatt (1929) made a number of observations on the Australian elapids, *Notechis scutatus*, *Acanthophis antarcticus*, *Denisonia superba*, and *Pseudechis porphyriticus*. They extracted venom from their specimens at monthly intervals for periods of 2 to 7 months. While they found that the average secondary yield for all species was lower than the average primary yield, there were exceptions among the individual snakes. Of 3 *Pseudechis* milked 5 times, one gave its maximum yield on the fifth extraction, and all gave more on the fifth milking than on the first. Two of 20 *Acanthophis* gave maximal yields on the fourth extraction. A *Denisonia* milked 7 times gave its maximum yield on the

fourth extraction, and the seventh extraction was almost twice the first. A *Notechis* milked 6 times gave its maximum on the first extraction, but the sixth was only 1.4 mg. less than the first. Marked variations on successive milkings were noted. One *Notechis* went from a low of 7 mg. to a high of 43 milligrams. Another dropped from 39 mg. to 7 mg., then bounced back to 30 milligrams. Kellaway (1929) found the toxicity of *Notechis* venom from secondary yields was approximately the same as that from primary yields providing the snakes were not diseased or starved.

Wolff and Githens (1939) made 16 venom extractions from a group of *Agkistrodon piscivorus* during a two year period. Average yield per snake fluctuated irregularly between 80 and 237 mg., and toxicity measured as the minimum lethal dose for pigeons varied from 0.05 to to 0.16 milligram. No clear trends are evident in their data, although lower yields tended to be obtained following shorter rest periods. The most toxic sample was obtained on the 14th milking, and the least toxic on the seventh. Both yield and toxicity were close to the averages for snakes milked for the first time.

George (1930) found that *Bothrops atrox* and *Crotalus d. durissus* gave lower average yields when remilked 25 days after primary venom extraction. Christensen (1955: 5) found second and third extraction yields from *Bitis arietans* averaged slightly lower than yields from snakes milked on arrival at the laboratory. Klauber (1956: 782–87) found that groups of *Crotalus ruber lucasensis* recovered 59 percent of their initial venom yield 27 days after milking and 90 percent 54 days after milking. A group of *C. atrox* gave 48 percent of their original yield 38 days after their original milking. He states that, in general, venom yields from rattlesnakes decline during captivity but believes that venom production might be maintained at normal level in well cared for snakes that were feeding readily.

The experiments reported here concern a male western diamondback rattlesnake, *Crotalus atrox*, collected August 7, 1955 at the north base of the Rosillos Mountains, Brewster County, Texas. The snake was probably about one year old. Its total length November 1, 1955 was 22½ inches (572 mm.). Since this snake was healthy and feeding readily, it was decided to collect venom from it over a period of several months. The first venom extraction was made November 1, 1955 and the 19th on May 31, 1957. At this time, the snake measured 43¼ inches (1098 mm.) and from all indications was in excellent health. The snake was kept in my laboratory where the mean temperature is about 76°F. with an approximate range of 65 to 95°F. Food was offered at five to seven day intervals, however the snake was not fed for a period seven days before and two days after venom extraction. When the snake was small, the food consisted of one 15–20 gram live or freshly killed white mouse per feeding. During the last nine months, it was offered two 25–30 gram mice or a half grown white rat. Food was rarely rejected, although feeding was often postponed until the laboratory was empty. Water was provided. Occasionally the water dish was upset or found dry, but there was no evidence the reptile ever suffered from thirst. The skin was shed normally. The snake's disposition did not seem to improve with captivity. Very little provocation would induce it to rattle. Any procedure involving opening of the cage had to be carried out with great caution, for the snake often struck unexpectedly. Very rarely, however, did it react by striking the glass front of its cage.

Venom extractions were made at approximately monthly intervals except during the summer of 1956 when 54 days elapsed between the July and August milkings. Before venom extraction the snake was carefully lifted from its cage and placed in a freezing chest. It remained there under observation until helpless, then it was removed, milked, and returned to its cage. On only one occasion during these manipulations did the snake struggle to such an extent that an appreciable portion of its venom was lost. Neither chilling nor milking seemed to injure the reptile, although it often seemed unusually irritable for several hours after venom extraction.

The venom was collected in a watch glass that was immediately placed in a small desiccator. After 24 hours, the dry venom was flaked off the glass and weighed. It was then returned to the desiccator over night and reweighed. This was repeated until the weight loss on two consecutive weighings was less than two milligrams. If toxicity tests of the sample could not be made immediately, the dry venom was stored over desiccant in the refrigerator. In no case did the interval between drying and testing of toxicity exceed three months.

TABLE I

Date sample collected	Weight milligrams	L.D.50 mg. /kilo	L.D.50 per mg.	L.D.50 in sample
11/1/55	46	11.65	4.29	197
12/1/55	40	16.0	3.12	125
1/2/56	44	12.8	3.91	172
2/4/56	43	14.7	3.40	146
3/5/56	71	15.6	3.20	227
4/3/56	63	13.2	3.79	239
5/3/56	103	17.6	2.84	292
6/1/56	152	15.5	3.22	490
7/2/56	170	17.5	2.86	486
8/25/56	89*	17.9	2.79	249*
9/29/56	103	19.1	2.62	270
10/29/56	107	16.75	2.99	320
11/30/56	124	15.9	3.14	390
12/29/56	169	19.25	2.60	439
1/28/57	137	16.3	3.07	420
2/27/57	143	20.3	2.46	352
3/28/57	201	25.3	1.98	397
4/30/57	264	26.0	1.93	508
5/31/57	236	18.5	2.70	637

* Considerable venom lost at time of milking.

For toxicity tests, the venom was dissolved in physiological saline in a concentration of 2 mg. per milliliter. White mice used in the tests were weighed individually, and the mice used for each venom sample did not vary more than 1½ grams from the median weight of the group. Venom dilutions spaced at 0.05 mg. intervals were injected subcutaneously into groups of six mice. From four to seven groups were used for each sample, groups being added until the lowest dose produced no more than one fatality and highest no more than one survivor. The 50 percent lethal dose (L.D.50) was calculated and expressed as milligrams per kilo of experimental animal. From this was calculated the number of L.D.50's per milligram of venom assuming the weight of an average mouse to be 20 grams.

Table 1 summarizes the data on venom yield, size of the lethal dose, number of lethal doses per milligram, and number in the entire venom sample. Data for venom yield and number of lethal doses per milligram are shown graphically in Figures 1 and 2.

Information on the venom yield of wild *Crotalus atrox* of various age and size groups is not available. It is my impression, however, that in terms of quantity of venom produced, this captive snake was little if any inferior to

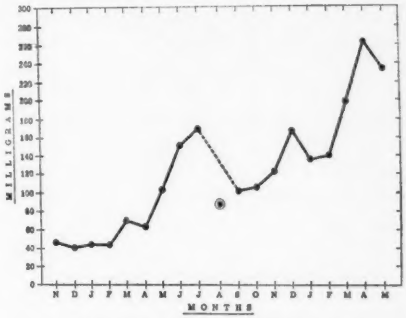


Fig. 1. Venom yields in Milligrams. The August yield (encircled) is too low; part of this venom was lost in extraction.

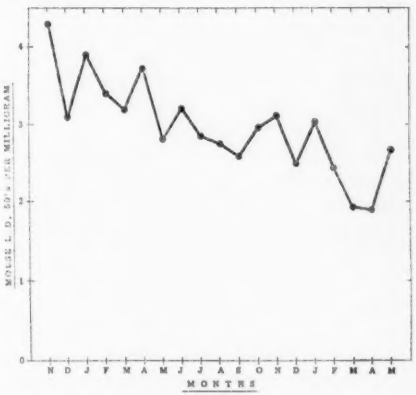


Fig. 2. Venom Toxicity in Mouse L.D.50's per Milligram of dried venom.

wild snakes from its range. During the last four months of observation, this *atrox* was as large as most of the adults observed in the Big Bend where the species seems to be appreciably smaller than in central and southern Texas. Its last three venom yields were not far below the average of 277 mg. given by Klauber (*op. cit.*, p. 775) for adult *atrox* in general.

Figure 1 shows that the production of venom was to some extent cyclic. For the first months of observation, November through January, the amounts of venom obtained were virtually the same. There was a slow increase during February and March, and a much more rapid increase during April, May, and June. In late September, however, the venom yield was only about 60 percent of that obtained in early July. Production increased slowly from October through February followed by a second sharp increase during March and April.

Variations in toxicity among the 19 samples are quite large. The mean L.D.$_{50}$ for all samples is 17.35 mg. per kilo with a standard deviation of 3.608. It is evident from Figure 2 that there is a trend toward lower toxicity during captivity, although a reversal of the trend is seen in the last sample collected. There is no indication of seasonal fluctuation. The toxicities of all the samples are low in comparison with a sample from ten adult to half grown *C. atrox* collected in the Big Bend and milked immediately after capture. This sample has a L.D.$_{50}$ of 7.50 mg. per kilo. Two other samples that I have tested have L.D.$_{50}$'s of 19.25 mg. per kilo and 15.0 mg. per kilo. Schottler (1951) with a similar technique found an L.D.$_{50}$ of 16.11 mg. per kilo. Criley (1956) reported 12 *atrox* samples contained 10 to 18 L.D.$_{50}$ per milligram. He used intravenous rather than subcutaneous injection, hence his data cannot be directly compared with mine.

The reasons for the observed variation and decrease in toxicity may be manifold. Deterioration of venom between collection and testing seems unlikely in light of previous experience; furthermore the weakest of the 19 samples was one of several tested immediately after drying. The relatively small number of mice used in the tests and certain uncontrolled variables involving these animals (e.g. sex, age, inherent resistance) are a possible source of variation. Perhaps the most significant factors may be those that involve the snake itself. Such things as undiversified diet, reduced sunlight, and lack of exercise may exert an attenuating effect on venom toxicity without obviously impairing the snake's general health. It may well be that some of the nontoxic or weakly toxic venom fractions are replaced more rapidly than those containing the powerful toxins, and this replacement may be relatively more rapid in older snakes than in the young. In an effort to confirm this experimentally, the December, 1956, January, 1957, and May 1957 samples were immunologically compared with the sample obtained from freshly caught Big Bend snakes. The Ouchterlony agar diffusion precipitin technique was used (see Grasset et al, 1956). This method showed no qualitative differences between the venom from the wild snakes and the samples from the captive specimen. Slight differences in the positions of the bands of precipitate indicate that some of the antigens are present in different concentration in the samples from the captive snake as compared with that from the freshly caught snakes.

Summary

Nineteen monthly venom extractions were made from a captive *Crotalus atrox*. During this time, the snake grew from a length of 22½ in. to 43¼ inches. The yield of dry venom varied from 40 mg. on the second extraction to 264 mg. on the eighteenth. The rate of venom production increased appreciably in the spring. Toxicity of the venom varied from a high of 4.29 mouse lethal doses per milligram on the first extraction to a low of 1.93 lethal doses per milligram on the eighteenth. The toxicity of all samples was lower than that of venom from freshly captured snakes from the same geographic area. There was a gradual decrease in toxicity of the venom during the period of captivity.

Literature Cited

Christensen, Poul A. 1955. South African snake venoms and antivenoms. *The South African Institute for Medical Research, Johannesburg:* v + *129*.

Criley, B. R. 1956. Development of a multivalent antivenin for the family Crotalidae. In *Venoms*, E. E. Buckley and N. Porges. Editors. *Amer. Assoc. Adv. Sci., Washington, D. C.: pp. 373–80.*

Fairley, N. H. and Beryl Splatt. 1929. Venom yields in Australian poisonous snakes. *Med. Jour. Australia, (1): 336–48.*

George, I. D. 1930. Notes on the extraction of venom at the serpentarium of the Antivenin Institute at Tela, Honduras. *Bull. Antivenin Inst. Amer., (4): 57–59.*

Grasset, E., T. Brechbuhler, D. E. Schwartz, and E. Pongratz. 1956. Comparative analysis and electrophoretic fractionations of snake venoms. In *Venoms*, E. E. Buckley and N. Porges, Editors. *Amer. Assoc. Adv. Sci., Washington, D. C.: pp. 153–69.*

Kellaway, C. H. 1929. The venom of *Notechis scutatus. Med. Jour. Australia, (1): 348–58.*

Klauber, Laurence M. 1956. Rattlesnakes. *University of California Press, Berkeley and Los Angeles: Vol. I, xxix + 708, Vol. II, xvii + 709–1476.*

Schottler, W. H. A. 1951. Toxicity of the principal snake venoms of Brazil. *Amer. Jour. Trop. Med., (31): 489–99.*

Wolff, Nigel O. and Thomas S. Githens. 1939. Yield and toxicity of venom from snakes extracted over a period of two years. *Copeia, (4): 234.*

Indiana University Medical Center, Indianapolis, Indiana.

Warning Behavior in Snakes of the Genus *Dasypeltis*

CARL GANS AND NEIL D. RICHMOND

IN THE course of recent work on the functional anatomy and systematics of the egg-eating snakes of the genus *Dasypeltis*, one of us (Gans) obtained 15 live specimens. The snakes were received through the courtesy of Mr. C. J. P. Ionides, lately of the Tanganyika Game Department, and were kept alive for varying periods (the maximum being three years for a specimen received April 1954, which is still living in the Carnegie Museum). They had initially been requested for experiments of feeding behavior only, but the opportunity was taken to observe and describe the unusual warning displays exhibited by several of the specimens.

HISTORICAL

The earliest report of warning reactions in *Dasypeltis* was given by Weale (1871: 508) in Nature, to which Darwin (1873: 106) and Mertens (1946: 24) later referred. Discussing "protective resemblances" of the animals of the South African Plain, Weale mentioned that the *Dasypeltis* of the Algoa Bay region (near Port Elizabeth), "coils itself up and darts angrily at the intruder, puffing and hissing loudly." He mentioned having observed such behavior on several occasions. Once he mistook a specimen of *Dasypeltis* for a night adder (*Causus rhombeatus*), and concluded that: "On comparing the two snakes I was much struck by their general resemblance, although of course, the *Dasypeltis* has a very dissimilar head; but the curious way it has of blowing itself out and distending its neck, and darting at intruders, heightened the resemblance. I cannot help thinking that these habits must be serviceable to so harmless a snake."

FitzSimons (1919: 106) also described the peculiar warning behavior. He reported that the snake coiled up and moved the body rapidly, "making a scraping sound by bringing the scales on the sides of its body in contact. Also it remains in the same spot all the time it is making this curious sound." His account is unfortunately marred by the statement (p. 106) that the snake never bites, whereas he subsequently states (p. 114) that it bites viciously.

Rose (1929: 161) mentioned that the snake "hisses" by rubbing together portions of its rough, keeled scaled body. In the second edition of the same book (1950: 260) he referred to a noise produced by rubbing the coils together and also remarked that the snake will strike with open mouth while simultaneously rubbing its coils.

Loveridge (1933: 246) collected a juvenile near Maji Malulu, Tanganyika, that struck out repeatedly and kept its mouth wide open until picked up.

Mertens (1946: 17) in his paper on "*Warn- und Droh-Reaktionen*" mentioned that *Dasypeltis* inflates itself as a "warning". In a later paper (1955: 105) he mentioned the open-jawed strike (in *Dasypeltis scabra loveridgei*), which did not terminate in a bite, and also noted that this form rubbed its body coils against each other so that "a definitely hissing noise was produced by the keeled (*sic*) and serrated keels of the lateral scales" (transl. by Gans). He also mentioned that this form differed from *Aspis* in soon ceasing this behavior in captivity.

OBSERVATIONS

Upon arrival from Liwale, Southern District, Tanganyika, the various individuals of *Dasypeltis scabra* all exhibited a more or less clearly defined sequence of warning or threatening reactions, with the exception of one adult female which started the warning cycle, but never struck.

The typical warning behavior involved three separate stages, apparently corresponding to levels of excitation. The stimulation or disturbance was provided by the introduction of a moving foreign body (hand, etc.) either in front of or above the specimen, by tapping against the glass front of the cage and finally by either tapping the specimen or pushing it sufficiently to disturb its position. Cessation of the disturbance at any time kept the warning reaction from progressing to the succeeding stage, though the snake often remained in the warning "coil" for five to ten minutes.

When first disturbed the snake inflated the

Fig. 1. Diagrammatic drawings of the formation of the warning position of *Dasypeltis*. 1a, beginning of "coil"; 1b and 1c shows successive positions of the body in the "coil". The adjacent parts of the body shown separated here are in life rubbing together as the snake moves.

anterior two thirds of its body. The greatest degree of inflation took place in the neck region, corresponding approximately to ventrals ten to thirty-five. In this region there often occurred a distinct vertical, as opposed to purely radial expansion that increased the height of the neck by about fifty percent. More posteriorly, the entire body expanded. At full inflation of the neck, the individual dorsal scale rows were separated by a wide area of intermediate skin. When the snake maintained this position for any length of time, its respiratory movements were generally accompanied by a hissing or wheezing sound.

Shortly after the body was inflated, or almost simultaneously in case of a severe disturbance, the snake coiled for striking. Superficially, the snake resembled any other coiled snake except that the body of the snake was in motion and the coil appeared to be swirling. Closer study disclosed the *Dasypeltis* does not form a true coil, but instead the body is folded in a series of parallel folds, the ends of which are brought forward to form a "C" shaped curve.

In the open part of the "C", the neck was held in a short "S" loop and the head was poised for striking. In this position the snake maintained a rapid crawling movement. As the body moved forward, the portion of the neck immediately posterior to the head moved to one side from the "S", producing a rapidly growing loop into which the body flowed. Before this loop reached full size, a second one, directed and travelling toward the opposite side, formed on the nape. As the first loop approached the outside of the "C", its growth slowed down though the posterior portion of the body continued to move through the "C" shaped loops. The "coil" thus maintained its shape and position while the body remained in motion. However, the "forward" motion of body was being taken up in successive loops of the neck; the head remaining in the same position while the anteriorly forming loops pushed the posterior part of the body backwards at right angles to the direction of motion.

As the loops of the body moved past each other, the rubbing of their scales produced a loud rasping or "hissing" sound. As the method of motion provided constant and extensive contact between two to three sections of the snake's body at all times, the sound was produced continuously. Figure 1 gives a series of schematic diagrams of successive positions in a single cycle.

The visual effect of this behavior was fully as remarkable as the auditory one. The snake appeared to be in a tight swirling coil, and the fact that adjacent portions of the body were going in opposite directions made it difficult to distinguish the outline of the specimen, judge its size, or determine its exact color pattern.

In the third and culminating phase of the behavior, the snake gaped widely and struck. The upper and lower jaws formed an obtuse angle during the gape. Throughout the period of the repeated strikes, the snake continued to produce the rasping noise. The strikes were always aimed to hit the offending object, but upon making contact the snakes neither bit nor chewed. The mouth was generally kept open between darts at the intruder.

In the artificial environment where these observations were made, it was noticed that less stimulation was required to elicit this behavior when the snake was confined in a cage than when it was crawling in the open. The usual behavior when released on the floor or table was to try to escape.

When the stimulation was stopped entirely,

the various components of the reaction were dropped in reverse order; i.e., the striking ceased, the mouth closed, the rasping became intermittent and the body deflated. Following upon this, the snake generally moved to a different location. Associated with this behavior is the observation that these snakes when at rest and undisturbed in their cages normally lie with their body in a series of folds that are in contact laterally. This position is the same as that described for the start of the "C" shaped coil.

Structural Modifications

There are two sets of structural modifications which permit the behavior described here, a tracheal air sac providing for the expansion of the neck and a series of specially inclined and serrated lateral scale rows involved in the generation of the rasping noise.

Inflation

The tracheal air sac was effectively demonstrated by the injection of colored gelatin through the glottis of a recently deceased specimen of *Dasypeltis inornata*, A. Smith, 1849.[1] The findings on this specimen were confirmed for the other species by dissection of a number of preserved specimens, and found to be basically the same.

As is typical for snakes, the trachea of *Dasypeltis* is reinforced by a series of semicircular, or "C" shaped, cartilage bars embedded in a layer of tissue which also closes the open end of the "C" to form a complete circle (Fig. 2).

Anteriorly, this closure into a ring is formed by a fairly thick inelastic band which completes the tracheal tube from the glottis posteriorly along the length of the hyoid. Immediately after leaving the hyoid, approximately at the level of the fifth vertebra, the connecting tissue becomes very much thinner and forms an extensive sac or tracheal expansion which extends back to the level of the heart. Here the tissue appears to become less elastic and heavier, and the expansion narrows down to expand again into the lung. As already mentioned by Cope (1894: 217), there is no division into bronchi, but the cartilage bars continue onto the side of the single lung.

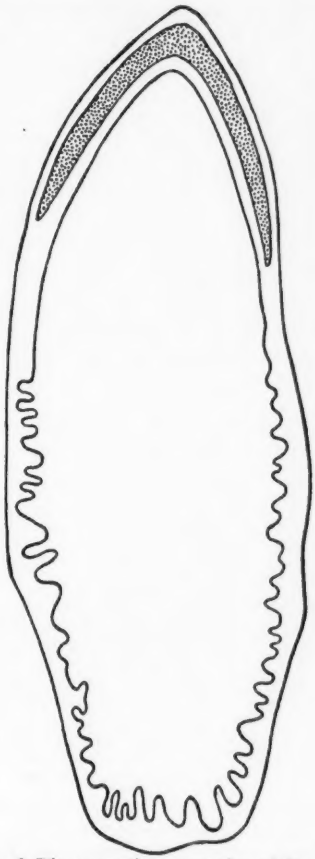


Fig. 2. Diagrammatic cross section of the expansible anterior trachea. Cartilage is shown shaded.

Beddard (1903: 322) in discussing the trachea of the King Cobra, *Ophiophagus hannah*, correctly described it as being open dorsally. Some authors (Wiedersheim, 1909: 550; Marcus, 1937: 949) apparently generalized from this report and the similar condition obtaining in lizards, to snakes as a group. In *Dasypeltis* the tracheal cartilages are definitely dorsal, with the expansion opening ventrally. There is also no such series of separate perforations as described by Beddard; but instead the sac is open to the trachea along its entire length, being in effect but an expansible portion of the trachea.

[1] This specimen, collected in Natal by R. B. Cowles of the University of California at Los Angeles, was kindly loaned by B. Brattstrom of the same institution. It was deep frozen shortly after death and the thawed specimen used for the demonstration of the tracheal air sac.

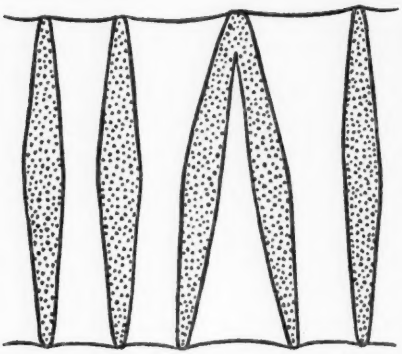


Fig. 3. View of the flattened trachea to show the cartilage bars.

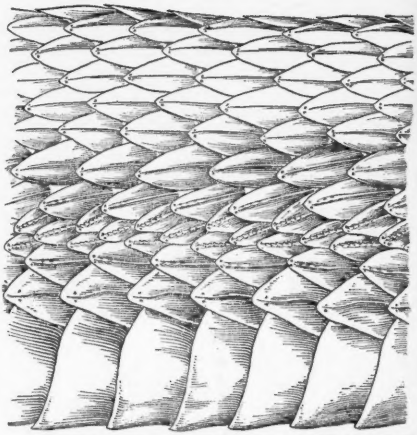


Fig .4. Lateral view of *Dasypeltis* (AMNH 12185) at midbody showing third, fourth and fifth rows of dorsals serrated, reduced and inclined.

As is shown in the Figure 3, the tracheal cartilages are widest and thickest at their center and the entire strip folds along the midline, so that the shape of each cartilage bar is closer to a "V" than to a "C". Histological examination showed the bars invested in a layer of smooth muscle and connective tissue (collagenous and elastic), which also made up the wall of the expansion (Fig. 3). The injected *D. inornata* as well as certain specimens, apparently preserved in the inflated condition, had the tracheal bars completely straightened and pressed dorsally against the flattened esophagous and the subvertebral musculature. Here the elastic tissue was stretched to the point where the plicae of its lining were fully extended, and the sac filled the entire body cavity anterior to the lung.

The method by which the neck is inflated is still puzzling even after repeated observations. The inflation appears to take place from the posterior air sac. The snake would thus seem to inflate the lung and air sac by normal inhalation, and then force some of this air forward into the tracheal air sac. Closing of the anterior trachea (glottis) by contractions of some of the anterior muscles would appear to be required for this. The contraction of some such muscle group can be observed in the live snake. By preventing escape of air, these muscles then permit the generation of a pressure in the neck region sufficient to inflate the tracheal air sac.

"Hissing"

Figure 4 shows a lateral view of a specimen at midbody. This shows the reduction in size, inclination and serration of the fourth, fifth and sixth rows of scales. Such serration occurs in all species of *Dasypeltis*, with the exception of *D. inornata* (nothing is known regarding the habits of this species) where the scales are reduced and inclined, but bear only traces of serration or none at all. It generally involves only three rows although the position of this serrate band may vary. Its location is generally along that portion of the snake's body which projects farthest laterally.

The serration involves breaking up of the keel into a series of sharp projecting points, each of which has a distinct conical shape. This serration may take place along the entire length of the scale, or along the distal portion only. The reduction in size of the individual scales and their close spacing provides for the presence of a maximum number of scales within the lateral "contact" region. Because of this and their inclination, which is 30° to 45° downward from the horizontal (parallel to the vertebral column), no horizontal line can be drawn through this area without intersecting at least one, but generally two, serrated keels in each segment. Consequently, any single serration peak theoretically will strike one or more serration peaks (or unbroken scale keels) for each segment along which it rubs. As there are between three and ten such peaks per scale, and the great majority of specimens have three serrated scales per segment, there will be

a high number of contacts per unit time. The auditory summation of these is registered as a "hissing", though actually a rasping or stridulating sound.

Since tracheal diverticulum, lungs and posterior air sac are entirely inflated during this performance, the sound is considerably amplified by resonance effects.

Discussion

The snakes of this genus form a group of relatively small and harmless species, whose greatly reduced dentition prevents their inflicting even an ordinarily painful bite. The necessity of frequenting exposed places imposed on them by their egg-eating habits and the savannah habitat of some species may be responsible for the development of a warning display. It seems clear that a behavior cycle of this type would offer some protection by itself due to its startling nature; however, there is some reason to suspect that another series of factors are also involved.

Beside Weale (*op. cit.*) a number of other authors have noted that the most widespread species of *Dasypeltis*, namely *D. scabra*, which shows a high degree of variation over its range, is often very similar in color pattern (Peters, 1882: 120; Anderson, 1898: 279; Werner, 1902: 340; etc.) and body proportions (Sternfeld, 1908, 1913, etc.) to various small vipers of the genera *Bitis*, *Echis* and *Causus*. Sternfeld in particular clearly stated his opinion that populations of *Dasypeltis* mimicked different vipers in various areas, though Werner (1909) strongly disagreed with this hypothesis. That such similarity in color pattern does exist may be seen from even a cursory comparison of color patterns, and a detailed discussion of this will be presented in a revision of the genus *Dasypeltis* to be published elsewhere.

Given a certain similarity of color pattern it is clear that the effectiveness of this would be improved by a behavior pattern that breaks up the general outline of the specimen, giving the predator only brief glimpses of the color pattern without permitting a clear picture of the entire animal. The simultaneous inflation of the body would also help to make the body proportions of *Dasypeltis* approach those of the generally heavy bodied vipers. The startling noise and rapidly repeated strikes would again offer additional effects distracting the predator from details of the color pattern. This is even more true since Rose (1955: 160; see also Mertens, 1953: 148, *et seq.*), for instance, mentions similar warning displays for several of the small vipers.

Obviously, such a warning reaction need not function as an absolute deterrent to predation. Even a moment's hesitation or indecision of the part of a predator may be of selective advantage to the intended prey. The value of the reaction would furthermore be increased by the escape phase, with the snake reaching cover before the possible predator could overcome its initial hesitation.

Finally, and apart from defense against predators, this warning display might also serve to intimidate the small birds whose eggs form the main food supply for this group of snakes.

A number of friends read the manuscript and we should like to particularly acknowledge comments offered by Ernest E. Williams, Clayton Ray, Karl F. Koopman, and Andrew J. Meyerriecks. Special thanks are due to Mr. Robert Zeigel, who prepared the tracheal sections. The illustrations are the work of Samuel B. McDowell, Jr., Miss Pat Washer, and Clifford J. Morrow, Jr. One of us (Carl Gans) completed this paper while studying under a National Science Foundation Fellowship.

Literature Cited

Anderson, John. 1898. Zoology of Egypt. Volume first. Reptilia and batrachia. *London, lxv + 379.*

Beddard, Frank E. 1903. On the trachea, lungs and other points of the anatomy of the Hamadryad snake (*Ophiophagus bungarus*). *Proc. Zool. Soc. London, (2): 319–25.*

Cope, Edward Drinker. 1894. On the lungs of the Ophidia. *Proc. Amer. Phil. Soc., 33: 217–24.*

Darwin, Charles. 1873. The expression of the emotions in man and animals. *London, vi + 374.*

FitzSimons, F. W. 1919. The snakes of South Africa. 3rd Edition. *Cape Town xvi + 500.*

Loveridge, Arthur. 1933. Reports on the scientific results of an expedition to the Southwestern Highlands of Tanganyika Territory. VII. Herpetology. *Bull. Mus. Comp. Zool., 74(7): 197–416.*

Marcus, H. 1937. Lungen. *In* Bolk, Göppert, Kallius, Lubosch. Handbuch der vergleichenden Anatomie der Wirbeltiere. *Berlin and Vienna, 909–88.*

Mertens, Robert. 1946. Die Warn- und Droh-Reaktionen der Reptilien. *Abh. Senckenberg Naturf. Ges., (471): 1–108.*

———. 1953. Die Wüstenottern und ihre An-

passungen an ihren Lebensraum. *Nature und Volk, 83: 148–56.*

———. 1956. Die Amphibien und Reptilien Südwestafrikas. *Abh. Senckenberg Naturf. Ges., (490): 1–172.*

PETERS, CARL WILHELM HARTWIG. 1882. Naturwissenschaftliche Reise nach Mossambique auf Befehl seiner Majestät des Königs Friedrich Wilhelm IV. in den Jahren 1842 bis 1848 ausgeführt. Zoologie. III. Amphibien. *Berlin, xv + 191.*

ROSE, WALTER. 1929. Veld and Vlei. *Cape Town xxiii + 240.*

———. 1950. The reptiles and amphibians of Southern Africa. *Cape Town, xxv + 378.*

———. 1955. Snakes—Mainly South African. *Cape Town, xvi + 213.*

STERNFELD, RICHARD. 1908. Mimicry bei afrikanischen Schlangen. *Sitzber. Ges. Naturf. Freunde Berlin (4): 89–91.*

———. 1913. Die Erscheinung der Mimicry bei den Schlangen. *Sitzber. Ges. Naturf. Freunde Berlin, (2): 98–117.*

WEALE, J. P. 1871. Protective resemblances. *Nature (London) 3: 507–508.*

WERNER, FRANZ. 1902. Ueber westafrikanische Reptilien. *Verhandl. zool. bot. Ges. Wien, 52: 332–348.*

———. 1909. Review of "Mimicry bei afrikanischen Schlangen." (Sternfeld, 1908). *Zool. Zbl., Leipzig, 16 (15/16): 514–15.*

WIEDERSHEIM, ROBERT. 1909. Vergleichende Anatomie der Wirbelthiere. 7th rev. Ed. *Jena, xx + 936.*

MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS AND CARNEGIE MUSEUM, PITTSBURG, PENNSYLVANIA.

Movements, Area of Activity, and Growth of *Rana heckscheri*

KEITH L. HANSEN

THE river frog, *Rana heckscheri* Wright is the least known ranid of the southeast. During 1953 to 1954 a study was made of 69 river frogs inhabiting Johnson Pond, north of Gainesville, Florida, to learn more about their life history, with particular emphasis on movement, area of activity, and growth. In addition, such factors as the spatial relations of individual frogs and their orientation with respect to the water's edge, the influence of temperature upon activity, and substrate preference were considered.

AREA OF STUDY

Johnson Pond is a 7.3 acre, sink-hole pond that acts as a drainage link in a chain of shallow cypress swamps and bayheads. The pond (Fig. 1.) receives water through an inlet stream, and overflows through an outlet stream only during times of heavy precipitation. The shore is surrounded by a heavy stand of hydric hammock, including such trees as *Taxodium distichum, Liquidambar styraciflua, Magnolia virginiana, Quercus nigra, Nyssa biflora,* and *Myrica cerifera.* Few aquatic plants are present. Species identified were *Hydrocotyle umbellata, Panicum hemitomon, Pontederia lanceolata, Lemna minor,* and *Riccia fluitans.*

The river frog was the most common anuran, followed in order of abundance by *Rana c. clamitans, R. pipiens sphenocephala, Hyla c. cinerea,* and *Acris gryllus dorsalis.* A few water snakes (*Natrix sipedon pictiventris*) and yellow-bellied turtles (*Pseudemys s. scripta*) were seen.

MATERIALS AND METHODS

A grid system of stakes (50 foot intervals) marked with letters (north-south axis) and numerals (east-west axis) was placed around the pond (Fig. 1.). Frogs were not caught along a part of the western shore because of dense overhanging vegetation nor in the low mucky area surrounding the outlet stream in the northeast corner because it was impassable on foot. There was approximately 2133 feet of shore line; 1483 feet (70 percent) was regularly traversed. The locations of captured frogs were determined in relation to the stakes.

The frogs were captured at night by shining their eyes with a head light. Each frog was numbered and marked by removing the two distal phalanges of the appropriate digits with scissors. No regeneration was noted. Only one digit usually was removed from fore or hind foot in order that normal locomotion may not be impaired.

Two body measurements were recorded—

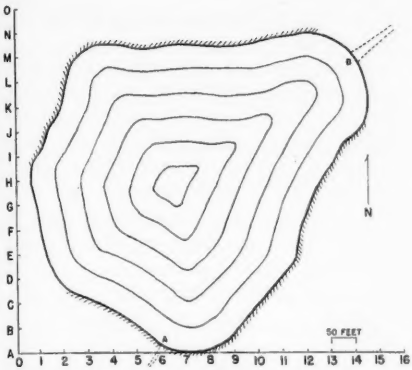


Fig. 1. Map of Johnson Pond north of Gainesville, Alachua County, Florida, where *Rana heckscheri* was studied, showing the grid system of stakes at 50-foot intervals. Inflow (A) and outlet (B) points of intermittent streams are shown and marginal hash marks indicate areas in which frogs were captured.

greatest head width (tenths of a millimeter; using vernier calipers) and snout-vent length, (millimeters; using a ruler attached to a block of wood). Also noted were degree of moistness and type of substrate at the point of capture, distance from the water's edge, the direction the frog was facing, relative humidity, air and water temperature, and water level.

Results

Since the same route was followed on each nightly visit and approximately the same time was spent in search of frogs, an estimate of frog activity could be made on the basis of the number captured. The frogs were active at air temperatures of 18° to 35°C. The optimum temperature probably approximates 25°C, since the largest number of frogs was collected on three nights having approximately this temperature.

That the frogs actively seek this temperature is evidenced by the fact that at air temperatures of 22°C and lower, individuals were often found in water having a somewhat higher temperature than the air (Table I). When in the water, they probably are able to remain active at sub-limiting air temperatures.

An estimate was made of the degree of moistness of the substrate where each frog was found. In 71 instances, 93 percent of the individuals were seated upon moist or wet substrates. Of this number, 37 percent had located themselves on sphagnum moss, a plant noted for its water holding capacity.

Table I

Air and Water Temperatures on Nights Frogs Were Captured in Shallow Water

Date	Total no. of frogs captured	No. of frogs in water	Air temp. (C.)	Water temp. (C.)
Oct. 17, 1953	9	1	19	24
Oct. 28, 1953	2	2	11	20
Nov. 21, 1953	1	1	22	23
Feb. 27, 1954	4	1	20	19
March 13, 1954	7	2	19	23
April 3, 1954	7	3	18	23
April 23, 1954	15	6	20	24

Excluding five extreme distances (those exceeding five feet), a mean distance of nine inches from the water was calculated for 55 frogs. Of 75 records, 81 percent were of frogs facing the open water, whereas only 19 percent were seated at right angles to, or turned away from, the water. In no instance was a frog seen to orient itself toward the pond due to the approach of the observer.

Each time a frog was captured, its exact position was determined. Distances moved by individuals were estimated and recorded along with the time intervals between captures. Practically no correlation existed between distance moved and time interval between captures (coefficient of correlation $r = 0.034$). If the frogs moved at random and did not maintain a home range, it would seem that distances separating sites of capture and the

Table II

Movements of *Rana heckscheri*

Frogs	Mean distance moved (feet) and standard error	Standard deviation	N	Significance
All individuals	33.7±0.42	2.5	38	—
Males	30.7±0.41	1.9	21	t.=1.0
Females	32.0±1.07	3.0	8	P.>0.05
Matures	32.4±0.46	2.6	29	t.=5.1
Immatures	37.5±0.87	2.6	9	P.<0.001

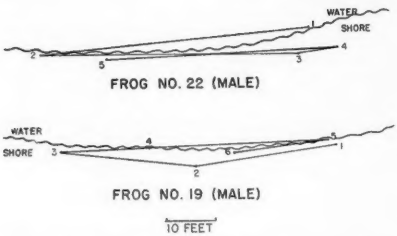


Fig. 2. Capture points along shore line for *Rana heckscheri* Nos. 19 and 22. The minimum area of activity includes the area within the outside capture points. See Fig. 3 for dates of first and last capture.

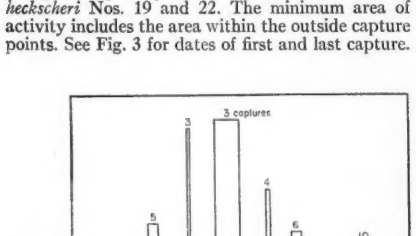


Fig. 3. Diagrammatic comparison of the greatest length and width of nine areas of activity of individuals of *Rana heckscheri*. Area of activity, number of captures, and sex of frog is also included. Frog No. 16 was first captured Sept. 25, 1953 and last taken March 13, 1954, No. 11 (Sept. 18, 1953–April 23, 1954), No. 22 (Sept. 18, 1953–April 23, 1954), No. 4 (Sept. 15–Oct. 15, 1953), No. 7 (Nov. 21, 1953–July 3, 1954), No. 17 (Sept. 25, 1953–April 23, 1954), No. 19 (Sept. 12, 1953–April 23, 1954), No. 14 (Sept. 12, 1953–March 13, 1954), No. 10 (Oct. 2, 1953–April 23, 1954).

lapse of time between captures would tend to increase together. The lack of correlation is indirect evidence that these frogs have home ranges.

The mean movement for all individuals was 33.7 feet (Table II). Distances moved by males and females are not significantly different ($P > 0.05$). On the other hand, juveniles moved significantly greater distances than adults ($P < 0.001$). This difference can probably be attributed to the fact that adults confine their movements to a home range, whereas juveniles, because they have not established definite ranges, move greater distances. Pearson (1955) found that small spadefoot toads (*Scaphiopus h. holbrooki*) tended to move greater distances from burrows in feeding than did large ones.

Little information is available on the home range concept in ectothermal vertebrates. The term *home range* or *activity area*, as used in this paper, is defined, following Dice (1952), as "the area over which an individual animal habitually travels while engaged in his usual daily activities." The areas of activity were determined for nine frogs by the "minimum home range" technique that involves plotting the capture points on graph paper and calculating the area within the peripheral points. Figure 2 shows such activity areas for frogs No. 19 (first captured Sept. 12, 1953 and last captured April 23, 1954) and No. 22 (Sept. 18, 1953–April 23, 1954). The outside points are considered the perimeter of the activity area, frog No. 19 having an activity area of 139 square feet, No. 22, 192 square feet.

The relative lengths and widths of nine activity areas are compared in Figure 3. The average length was 58 feet; the mean width was 5 feet. Note the markedly elongate pattern of the activity areas; the average length was approximately twelve times that of the width. Since this species never moves far from the water in feeding and yet needs considerable foraging area, the region of activity must necessarily be elongate.

Since dimensions for only nine activity areas are available, the size of the home range for the species is uncertain. However, the average

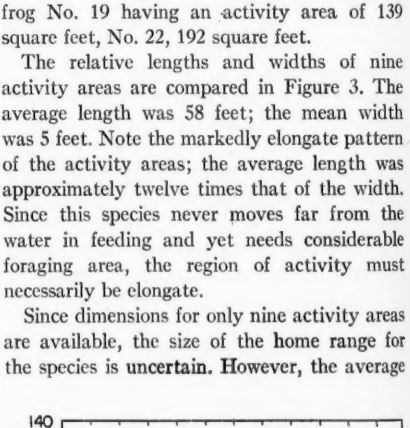


Fig. 4. Snout-vent length of individuals of *Rana heckscheri* in relation to dates of capture.

for these nine activity areas is 172 square feet, approximating that of *Rana clamitans* given as approximately 200 square feet (Martof, 1953).

Ratios were calculated of head width against snout-vent length for 45 males (32.5 ± 0.38) and 26 females (31.6 ± 0.62), but no significant differences between means was shown ($P > 0.05$).

A composite growth curve for the species could not be made. However, facts came to light when growth in snout-vent length was plotted against time (Fig. 4). Juveniles, as with most animals, grow at a faster rate than adults. Frog No. 4, a juvenile, grew 11 mm. in 30 days (Sept. 15 to Oct. 15, 1953), whereas an adult male, No. 22, grew only 2 mm. in approximately the same period of time (Sept. 18 to Oct. 15, 1953). Likewise, juveniles No. 1 and 2 grew 6 and 4 mm. in 21 (Sept. 18 to Oct. 9, 1953) and 27 days (Sept. 18 to Oct. 15, 1953), respectively.

Growth was recorded during the warmer months (March through October), when presumably metabolism is highest and food most abundant. In 1954, frogs Nos. 7 (captured April 23 and again July 3), 8 (July 3–Aug. 5), 10 (April 3–April 23), 13 (June 3–July 3) and 19 (Feb. 27–April 23) showed relatively rapid growth during the spring and summer. Records for individuals No. 1, 2, 4, and 14 indicate that growth continues into October in Florida. Growth was retarded during the colder months (November through February) and in several instances individuals shortened in body size.

Discussion

It seemed surprising to find this frog, which normally inhabits swamp streams, thriving in an open pond, but upon finding that Johnson Pond was a drainage link between adjacent swamps and bayheads, I was no longer puzzled. I have observed that drainage basins having little or no current collect unusually large numbers of river frog tadpoles. I have assumed that many were washed into such basins as the result of flood conditions in incoming streams.

The river frog proved an ideal species from which to take body measurements. They remained quiet and relaxed when held. Carr (1940) noted, "When caught, it hangs limp in the hand never resorting to the vigorous kicks and contortions characteristic of *Rana grylio* and *R. catesbeiana*."

Although the exact lower limiting air temperature was not determined, it seemed that individuals remained in the water on cool nights. The lower limiting temperature for this frog was assumed to be about 17°C (62°F), since no animals were taken except when seated in water warmer than the air at air temperatures lower than 18°C. This is in close accord with observations on *Rana clamitans*, for this frog withdraws from the banks into the water at air temperatures of 60°F (Martof, 1953).

The fact that the river frog was consistently found seated upon moist or wet substrates suggests that this type substrate is actively sought to prevent desiccation.

Individuals were found seated usually around the edge of the pond and facing the water. The water is perhaps the frog's best protection from terrestrial predators and the habit might well have survival value.

The pond is 500 to 600 feet in diameter, thus it becomes obvious that individuals would almost necessarily be restricted in their foraging to a given marginal area. The capture points in Figure 2 suggest that the frogs move back and forth along the shore line. It is likely that individuals living along swamp streams occupy both sides. Martof (1953) found that individual green frogs occupied home ranges which included both sides of narrow streams.

Literature Cited

Carr, Archie F., Jr. 1940. A contribution to the herpetology of Florida. *Univ. Florida Publ., Biol. Sci. Ser., 3 (1): 1–118.*

Dice, Lee R. 1952. Natural communities. *Univ. Mich. Press, Ann Arbor: x + 547.*

Martof, Bernard S. 1953. Home range and movements of the green frog, *Rana clamitans*. *Ecology, 34 (3): 529–43.*

———. 1956. Growth and development of the green frog, *Rana clamitans*, under natural conditions. *Amer. Midland Nat., 55 (1): 101–17.*

Pearson, Paul G. 1955. Population ecology of the spadefoot toad, *Scaphiopus h. holbrooki* (Harlan). *Ecological Monogr., 25 (3): 233–67.*

Department of Biology, Stetson University, DeLand, Florida.

Hibernation, Hibernacula and Associated Behavior of the Three-Toed Box Turtle (*Terrapene carolina triunguis*)

CHARLES C. CARPENTER

THE three-toed box turtle (*Terrapene carolina triunguis*) is a common inhabitant of lowland forest areas, and particularly flood plain forests, of eastern Oklahoma. The following study was made on the Oliver Wildlife Preserve of the University of Oklahoma, 2 miles south of Norman, Cleveland County, Oklahoma. This preserve, during the time of the study, consisted of approximately 60 acres, of which 50 acres were flood plain forest of the South Canadian River. The large cottonwoods are being replaced by American elm, green ash and persimmon (Penfound, 1948). Undergrowth is sparse, greenbriar (*Smilax*) being the dominant shrub, partly due to heavy grazing by twenty head of cattle. Six small pools, ranging from 100 to 500 square feet of surface area, are located along the base of the hill running along the north side of the preserve. Only one of these pools contains water for more than two or three months of the year.

Accounts of hibernation in box turtles (e.g. Allard, 1935; Penn and Pottharst, 1940; Stickel, 1950 and Whetmore, 1920) are generally superficial. The abundance of the three-toed box turtle in the Oliver Wildlife Preserve and the development of a technique for locating box turtles hidden in debris or buried in the soil made a study of the hibernal ecology and behavior of this turtle feasible. This study includes data for the fall, winter and spring seasons of 1953–54, 1954–55, and 1955–56.

The Oliver Wildlife Preserve is marked off into quadrats of 100 feet on a side. Records of position of active turtles or hibernacula were recorded in distance and direction from these markers, or were individually marked using a wire stake with a metal tag containing a stamped code number. Using the wire stakes, it was possible to return to the exact location of a previous record. Each turtle captured was marked by notching a code number on the marginal scutes with a rat-tail file. Data recorded included the number of the individual, the number of times captured, date, time of day, sex, length and width of carapace, position on preserve, activity or special type of behavior, associated animals and plants, details of surrounding ecologic niche, such as air and soil temperature, sky and moisture conditions, and, incidentally, color and scute variations.

The technique used for finding hibernating turtles (Carpenter, 1955) consists of sounding by using an aluminum cane-like rod (a cane-like stick will also work) in places where turtles might be. If one is present, the sound of the rod striking the carapace is readily distinguishable.

There are five species of turtles present on the preserve. *Chelydra s. serpentina*, *Kinosternon f. flavescens*, *Pseudemys scripta elegans*, *Terrapene o. ornata*, and *Terrapene carolina triunguis*. The latter far out-numbers all other species, but is frequently found associated in hibernation with the others.

A total of 473 individuals of the three-toed box turtle has been marked, while the shells of 91 other individuals have also been recorded on the preserve. The records used include only those living individuals observed between October 1 and March 31, arbitrary dates, hibernation generally beginning in October and ending in March, though turtles may enter seclusion before and emerge after these dates. Between these dates, 607 separate observations were made representing 344 individuals. Of the 607, 147 (24 percent) were active and not in hibernation, while 460 (76 percent) were in shallow or deep hibernacula. The 460 represents 295 different individuals.

The three-toed box turtles begin to enter hibernation in October, and by November the great majority are to be found in hibernacula (Table I). Throughout December, January and February, they are rarely active, but by mid-March, emergence from hibernacula is indicated by increased records of active individuals.

The situations or habitat niches used for hibernacula vary greatly, but have certain common features. These features are some sort of cover (shrubs, brush piles, logs or leaf litter) and, usually an association with natural depressions or cavities, and soft soil conditions.

TABLE I

SEASONAL VARIATION OF HIBERNATION AND HIBERNACULA OF *Terrapene carolina triunguis*
Oliver Wildlife Preserve, Cleveland County, Oklahoma, 1953–1956

Month	Number in hibernacula												Depth of hibernacula											
	Number Turtles Captured				Number Turtles in Hibernation				Per Cent in Hibernation				Leaf Litter			Average of Total*	Soil			Average of Total*	Total			Average of Total*
	53–54	54–55	55–56	total	53–54	54–55	55–56	total	53–54	54–55	55–56	total	53–54	54–55	55–56	53–56	53–54	54–55	55–56	53–56	53–54	54–55	55–56	53–56
Oct.	85	70	44	199	33	17	23	73	39	24	52	37	1.5	1.8	1.3	1.5	0.3	0.1	0.5	0.3	1.8	1.8	1.8	1.8
Nov.	33	64	27	124	30	58	22	110	91	91	82	89	1.1	2.6	2.3	2.1	2.4	1.7	1.8	1.8	3.5	4.3	4.1	4.1
Dec.	35	26	19	80	34	26	19	79	97	100	100	99	1.8	4.9	3.4	3.3	3.0	1.8	2.1	2.4	4.8	6.7	5.5	5.6
Jan.	27	37	20	84	27	37	18	82	100	100	90	98	1.6	3.0	4.8	2.9	3.9	2.8	1.2	2.8	5.5	5.8	5.9	5.8
Feb.	24	29	17	70	24	29	17	70	100	100	100	100	1.7	3.9	3.8	3.1	5.9	2.1	1.9	3.4	7.6	6.0	5.7	6.5
Mar.	9	27	8	44	7	25	8	40	78	93	100	91	1.5	2.5	4.7	2.8	6.6	1.7	1.6	2.5	8.1	4.2	6.4	5.3
Total for all months	213	253	135	601	155	192	107	454	73	76	79	76												
Average of totals for all months													1.6	3.1	3.1	2.6	3.1	1.8	1.5	2.2	4.6	4.9	4.6	4.8

* The averages are taken from data totals and are not means of the averages.

The hibernaculum usually is a cavity made by the turtle as it digs and forces its way downward. The material above the turtle generally consists of the loose dirt or litter left by the activity of the retreating turtle. This loose material is easily penetrated by the sounding instrument.

The type of hibernacula most commonly observed (Table II) was called "old stump hole". These are formed on the flood plain when dead trees rot off or are pushed over at the base. The underground stump or base deteriorates leaving a cavity containing soft, rotting wood, which, when the wood is gone, fills with leaf litter or other debris. Of similar type, are furrows left by rotted logs and small natural hollows in the forest floor, which also fill with debris and leaf litter.

On the sides of the hill, the gulley bottoms often filled with litter and were frequently used by the turtles for hibernacula. The accumulations of leaf litter and debris at the sides of fallen trees, rotting logs, and at the base of the steep hillside was also the site of many hibernacula. Leaf litter often was caught at the base of the abundant greenbriar and clumps of blackberry, and this type of situation was very commonly sought by the turtles for winter retreat. When conditions, as described above, were located on the side of the hill, they proved to be especially attractive as areas for hibernation.

As implied above, certain of these conditions were often found together, that is, a brush pile

TABLE II

THE RELATIVE IMPORTANCE OF ENVIRONMENTAL FACTORS IN HIBERNACULUM SELECTION OF *Terrapene carolina triunguis*

Type of environmental factor	Number of individuals*	Per cent in association
Cavity (stump hole, hollow, etc.)	179	39
Bushes and thick vegetation	153	33
Hillside	104	22
Gulley bottom	60	13
Piles of brush and debris	50	11
Log	40	9
Base of hill	21	5
Sandy soil	23	5
Other	13	3

* The total number of individuals was 460, but this column totals much more because an individual hibernacula may have exhibited two or more recorded environmental factors. Thus the percentages do not total 100, but are greater for the same reason.

over an old stump hole filled with leaf litter, greenbriar and leaf litter on a sandy area, logs blocking a dam of debris in a gulley bottom, and leaf litter covering a brush pile. The relative significance of each of these factors is indicated in Table II.

As the winter progressed and the weather became cooler, the depth of the turtle in the hibernaculum increased. Measurements were made with a graduated sounding-rod; the depth down to the top of the carapace was recorded. Covering materials were classified as two types; leaf litter, which included new fallen leaves, leaf mold, and debris of similar texture; and soil, which included humus, sand muck and similar substances. For soil to be registered in this depth measurement, it had to be covering the carapace, thus many turtles covered by leaf litter may have had their plastrons partially buried in the soil. The fresh leaf litter became packed into a thinner layer as winter progressed so that the packing factor would seem to decrease the thickness of this layer. Yet the recorded depth of the leaf litter above the turtle increased indicating that the turtles sought greater depths. This increase in depth is also indicated by the soil measurements (Table I, Fig. 1). This pattern of progressive depth increase is similar for each of the three winters of observation.

The greatest depth recorded for a hibernating three-toed box turtle on the preserve was 18 inches beneath the leaf litter, other maxima being 16 inches (6 leaf litter, and 10 soil), 10 inches (1 of leaf litter and 9 of soil). The overall average depth for hibernacula was 4.8 inches (2.6 leaf litter, 2.2 soil). If the shallow depths of October are not included, the average would then be 5.3 inches (2.8 leaf litter, 2.5 soil). The average depth for each month and year are shown on Table I.

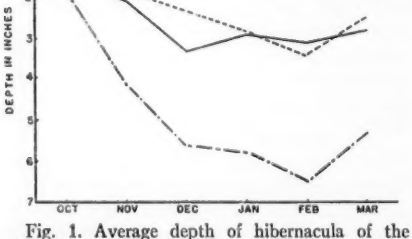


Fig. 1. Average depth of hibernacula of the three-toed box turtle, Oliver Wildlife Preserve, Cleveland County, Oklahoma. October–March, 1953–1956.

The distribution of the hibernacula was directly related to the presence of favorable conditions. Areas lacking cavities, hollows or depressions on the flat forest floor had few hibernating turtles, while areas with these features, sometimes very slight depressions, with few exceptions, had a turtle in them at some time during the three year study. The hillside gulley bottoms and the vegetated sand dune area had the greatest concentrations. On November 11, 1954 on the sand dune area covered with greenbriar, 18 hibernacula were located in an area of 1500 square feet, 14 of these being in an area of only 600 square feet. Other similar concentrations were found on gulley bottoms of the hillside.

Turtles were frequently aggregated in old stump holes, two and three in one hole being common. On January 8, 1955, six individuals were removed from an old stump hole measuring 2 feet in diameter, and five of these occupied only about one third of this depression. Three or four turtles were often found in one hibernaculum. Where the diameter of the hole was small, turtles were found stacked one above the other in twos and threes, plastron on carapace. Approximately 53 percent of all hibernating turtles observed were within one to two feet of another hibernating individual. This grouping was usually with another of the same species, but close associations with *Terrapene o. ornata* and/or *Kinosternon f. flavescens* were not rare, and mutual occupation of a hibernaculum with *Chelydra s. serpentina* was also recorded. Salamanders (*Ambystoma texanum*), skinks (*Eumeces fasciatus*) and many types of invertebrates (beetles, earthworm, sow bugs, snails) were taken from the same cavities with hibernating turtles.

Turtles were found headed in and headed out of the hibernaculum; with the left or the right side in, and in some instances they were arranged in a vertical position with the head end usually up. Frequently, when two or more were in the same hibernaculum the shells would be touching, or one would lie above the other. Often the soil was packed solidly around

the shell, especially if the dirt was wet or moist. If the soil was loose or somewhat drier, then the movements of the turtle often formed a small cavity about the shell. The plastron was closed against the carapace in the majority of instances where an attempt was made to determine this point.

The hibernacula varied from damp to wet, (that is, the soil often contained enough moisture to form muck) but in no instance was a turtle found under water. No hibernaculum was found to be without some dampness. It is probable that when dry conditions approached, the turtle sought a new and damper location.

The longest period of time recorded for an individual remaining in the same hibernaculum throughout the same season was 154 days (November 11 to April 8 and observed during this period 7 times). Two individuals were recorded for this length of time. The records of time spent by a particular individual in a particular hibernaculum give some estimate of the stability of hibernation. Occupied and unoccupied hibernacula were revisited at various intervals of from a few days to a few weeks, so that the period of time indicated as being spent at a particular point is a reflection of the intervals between re-checks. A record was made both of the presence or absence of a previously observed individual in a certain location. This re-checking procedure gave the evidence that many of these turtles move about during the winters. A majority of these turtles move at least once during the period of hibernation. Other than the two individuals which remained in the same hibernacula for 154 days, nine remained from 110 to 149 days, thirty-seven from 60 to 99 days, fifteen from 30 to 59 days and fifteen from 1 to 29 days.

The average length of time these 73 turtles remained in the same hibernacula was 63.4 days.

Certain hibernacula were occupied by ten different individuals over the three year period. Evidence such as this indicates that individual turtles may not form associations with any particular hibernacula. Though many individuals did show a tendency to be permanent in the hibernaculum, many were frequently changing hibernacula. It may be thought here that the capture and handling by the worker would stimulate the turtle to seek a different hibernaculum. However, this was not necessarily true as the known hibernacula were periodically checked to record those present. In making these checks, it was usual to find a new (unmarked) individual had moved in between checks. This unmarked individual had not been previously disturbed by this observer (and presumably no other observer) so that its move to a new hibernaculum was at least not human provoked.

Distances between hibernacula, measured from plotted records on scale maps of the preserve, indicate a great variation in the tendency and/or non-tendency of individuals to return to hibernacula they had previously occupied. All conceivable variations were recorded. Eighteen turtles returned to exactly the same hibernacula in which they had been observed during the previous season. Two individuals were found using the same hibernacula for three successive seasons. Four returned to the same hibernacula they had used two seasons before (not present the season between). Sixteen other turtles returned to hibernacula within 30 feet of those used the year previous.

Sixty additional individuals were observed in new hibernacula (exceeding an arbitrary thirty feet) in successive years. The maximum distance apart of two successive hibernacula in consecutive seasons was 1200 feet, three others exceeding 500 feet, twenty between 201 and 500 feet and thirty-six between 30 and 200 feet. The average distance apart for all successive hibernacula, exceeding 30 feet, in consecutive seasons was 243 feet, with the average for all hibernacula where any change in successive years was involved, being 197 feet. A similar average taken to include all those distances between successive hibernacula in successive years (including those returning to the same hibernacula), was 162 feet.

Within the same season, change from one hibernaculum to another was frequent and involved distances varying from a few feet (one old stump hole to another a few feet away) to 940 feet (20 days later). The intervals of time involved ranged from 4 days (40 feet) to 137 days (243 feet). For 45 turtles that changed hibernacula locations in the same season, the average distance involved was 168 feet. This figure is similar to the one stated above (162

feet) for successive seasons, and it may be related to the size of the activity range of this species. Four turtles were recorded as changing their hibernacula twice in the same season, but it is certain that this number should be very much higher. This is true because many of the individuals noted as changing location once in the same season, were not present at the second hibernaculum on further check. These changes of hibernacula during the winter are puzzling, for very few observations were recorded where active turtles were observed. Warm winter days and heavy rains probably stimulated these movements, but the questions when and how cannot be adequately answered from data gathered during this study. Most changes take place in the late fall and early winter.

Without a doubt, a factor which works against finding more turtles returning to the same hibernaculum in successive seasons, is that the hibernacula themselves may undergo natural change so that they are no longer available or adequate for hibernation. Many such instances as this were observed. Old stump holes, cavities and hollows were frequently eroded full of hard soil, covered by heavy logs, or were bare of any protective debris or leaf litter which had been previously present. Gulley bottoms used by turtles one year were sometimes swept clean of protective debris or litter by heavy rains. A turtle returning to its former hibernaculum may have found it completely occupied by other turtles, so that it had to seek cover elsewhere. The close proximity of many hibernacula in successive years would be evidence to support this contention that they may try to return to a location they have used.

The situations used as hibernacula during the winter season were also used for aestivation or temporary retreats during hot weather. Three turtles observed in probable aestivation during hot weather were later observed at the same location in hibernation. One turtle, found in aestivation on September 24, was in hibernation at the same spot on November 14. It is possible that many turtles may pass from aestivation to hibernation in the same retreat without becoming active.

Mortality in hibernation is difficult to measure, though it was believed to be high in the population observed. Numerous shells were recorded on the surface in late winter and spring. However, many shell remains were also recorded in summer and fall. Approximately one half of these shells were unmarked indicating that the observers handling was probably not of any consequence in mortality. Perhaps much of the mortality was due to the severe drouth in the southwest over the latter two years of study. Analysis of mortality data is being studied for a future report.

Whether winter kills, or predator kills, many dead turtles were found that had signs indicating they had been fed upon, that is, legs, head, and viscera had been removed. Living individuals were observed with severe injuries and some of these were noted to have been very recently recorded from hibernacula close by.

The Oliver Wildlife Preserve has had a large population of the three-toed box turtle. It can be assumed that a factor supporting this large population is the presence of numerous situations, cited above, suitable for hibernation. A similar relationship has been postulated by this author for garter snakes in Michigan (Carpenter, 1953).

Literature Cited

Allard, H. A. 1935. The natural history of the box turtle. *Sci. Monthly, 41: 325–338.*

Carpenter, C. C. 1953. A study of hibernacula and hibernating associations of snakes and amphibians in Michigan. *Ecology, 34: 74–80.*

———. 1955. Turtle sounding: a field locating technique. *Herpetologica, 11: 120.*

Penfound, W. T. 1948. An analysis of an elm-ash flood plain community near Norman, Oklahoma. *Proc. Okla. Acad. Sci., 28: 59–60.*

Penn, G. H. and K. E. Pottharst. 1940. The reproduction and dormancy of *Terrapene major* in New Orleans. *Herpetologica, 2: 25–29.*

Stickel, L. F. 1950. Populations and home range relationships of the box turtle, *Terrapene c. carolina* (Linnaeus). *Ecol. Monogr., 20: 351–378.*

Whetmore, A. 1920. Observations on the hibernation of the box turtle. *Copeia, No. 77: 3–5.*

Department of Zoology, University of Oklahoma, Norman, Oklahoma.

Alphestes scholanderi, A New Sea Bass from the West Indies

VLADIMIR WALTERS

DURING the winter of 1951–52 the writer assisted Dr. and Mrs. Per F. Scholander in a physiological study of deep water fishes at the Lerner Marine Laboratory, Bimini, Bahamas. On one of our deep-water fishing trips a brassy-colored serranid was captured. Since the fish did not seem to belong to any of the familiar species of grouper occurring near Bimini it was given the field name of Golden Grouper and brought back to the laboratory to be placed in the laboratory collection. During the following winter (1952–53) the Scholanders caught two more Golden Groupers off Bimini; these, too, were preserved and placed in the laboratory collection. In mid-1953 the three fish were shipped to New York for examination. Owing to hot weather and inadequate storage facilities it became necessary to skeletonize the specimens. Mr. Marshall Bishop, then resident naturalist at Bimini, was asked to collect and preserve a fourth fish. In July of 1954 the fourth specimen was obtained and shipped to New York. The drawings were prepared by Samuel Booker McDowell, Jr.

The description below was determined in the following manner. The last element was not included in the counts of soft dorsal and anal rays. All pectoral elements were included in the count of that fin. Scale counts were made from immediately anterior to the first dorsal spine diagonally downward to but not including the lateral line, along the lateral line from behind the gill opening to the bases of the caudal fin rays, and from immediately anterior to the first anal spine diagonally upward to but not including the lateral line; scale count is difficult to determine in this species. Fin and gill raker counts, save for the caudal count, were taken for all four types; the caudal ray count was determined for AMNH 19925. Proportional measurements were taken for all four types, save for body depth in standard length and caudal peduncle depth in standard length which could not be determined for AMNH 19925. The account of the neurocranium was based on AMNH 19924, 19925, 19926. Squamation details were taken from AMNH 19925, 19926, 20230. Dentition, fin characteristics, and morphology of the head were taken from the four types. Coloration in preservative was based on AMNH 19925, 19926, 20230; coloration in life was taken from a 35-mm. Kodachrome transparency of the holotype, AMNH 19925, photographed by the author a few seconds after the fish came to the surface and before it was lifted into the boat.

Alphestes scholanderi, *sp. nov.*

Golden Grouper

HOLOTYPE.—AMNH 19925; collected December 29, 1951 west of Bimini, Bahamas at a depth of 1300 feet; standard length 760 mm., complete skeleton.

PARATYPES.—AMNH 19924; collected December 13, 1952 west of Bimini, Bahamas at a depth of 1224 feet; standard length 750 mm., neurocranium. AMNH 19926; collected January 27, 1952 west of Bimini, Bahamas at a depth of 1290 feet; standard length 930 mm., skull. AMNH 20230; collected July 19, 1954 west of Bimini, Bahamas at a depth of 1500 feet; standard length 810 mm., complete specimen.

DESCRIPTION.—D XI, 13-14; A III, 9; P_1 17-19; P_2 I,5; C 24 (9 + 7 = 16 branched); 16 gill rakers on lower limb of first arch; scales 27 to 28—about 80—36 to 38; vertebrae 10 + 14 = 24.

In standard length: head 2.4–2.6, body depth 2.8–3.1, caudal peduncle depth 8.5–9.0. In head length: orbit 7.0–9.0, interorbital 4.8–5.3, postorbital head length 1.8–1.9, pectoral fin 1.9–2.1, pelvic fin 2.3–2.5, longest dorsal spine 2.3–4.0, snout to rear of maxillary 2.1–2.2.

The neurocranium of the holotype is shown in Figures 2 and 3. The premaxillary processes do not reach the frontals and terminate in a cavitation in the ethmoid anterior to the orbits. The frontals lack a transverse ridge; instead there is a postorbital frontal process on each side behind the interorbital area. The parietal crests are knife-edged and concave, running onto the frontals, and are confluent with the postorbital frontal processes. The supraoccipital crest is high, does not extend onto the frontals,

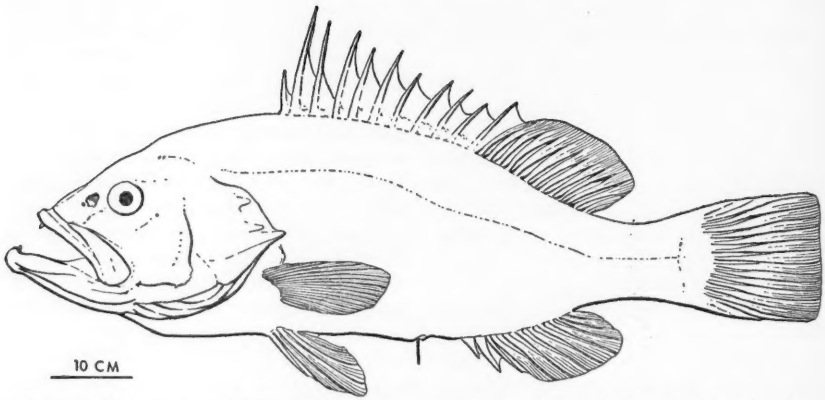


Fig. 1. Left lateral aspect of AMNH 20230, paratype of *Alphestes scholanderi*. Standard length 810 mm. Color pattern and squamation omitted from drawing.

and ends anterior to the rear of the orbits. The interorbital area is concave and broad; its least breadth exceeds the diameter of the orbit.

The scales are cycloid on the head and ctenoid on the body. The lateral line scales are feebly ctenoid and are notched. There are no supernumerary scales on the body. The maxillary and supplement are scaled.

The teeth are small. Canines are scattered in the upper and lower jaws, with 4 robust ones at the anterior ends of the upper and lower jaws on each side. All teeth except the outer row in the upper jaw and a few outer ones in the lower jaw are depressible. The mandibular teeth are in 2, 3, or 4 rows. The vomer and palatines are toothed. The tongue is toothless.

The second and third dorsal spines are much higher than the others, and the second almost equals or exceeds the third in length; the fourth and sixth dorsal spines are longer than the fifth; the distance between the bases of the third and fourth dorsal spines is greater than that between the bases of the second and third or fourth and fifth spines, and the dorsal fin membrane between the third and fourth spines is lower than that between the second and third or fourth and fifth spines (Fig. 1). The second anal spine is strong and measures 0.6–0.8 the length of the third anal spine. The caudal fin is truncate. The pelvic fins are inserted behind the pectorals, and the pelvics do not reach the anus.

The maxillary ends beneath the pupil. The mandible projects and is knobbed at its tip. The width of the maxillary plus supplement is about equal to the orbital diameter. The nostrils are very close together, and the posterior nostril measures 2.1–3.7 times the horizontal diameter of the anterior nostril (Fig. 1). The interorbital space is convex and broad, about 1.5 times the diameter of the orbit. The gill rakers are spiny and measure less than the pupil diameter. The upper limb of the preopercle is vertical and is notched above the angle, with the serrations small and blunted; the angle of the preopercle is rounded and has blunt serrations; the lower limb of the preopercle has a small antrorse spine near the angle (Figs. 1 and 4). The three opercular spines are more or less hidden in the skin, with the middle spine more conspicuous than the others. In Figure 1, the lowermost spine is not shown at all, since it can be located only by touch. What appears to be the lowermost spine in the drawing is a stiffened portion of the opercular flap which extends caudad from between the two lower opercular spines. The middle opercular spine extends further back than the others; the uppermost and lowermost spines end at about the same vertical; the tip of the middle spine lies closer to the tip of the lowermost spine than to the tip of the uppermost spine.

In preservative the coloration is reddish brown with traces of many dark vertical bands; dark mustache; fins dusky with pale edges, no spots or blotches; mouth and gill chamber dusky; no dark points about the eyes. When alive, the body is coppery gold with about 18

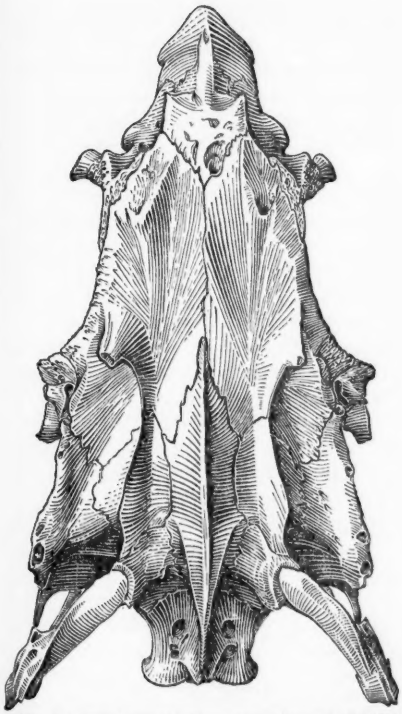


Fig. 2. Dorsal aspect of neurocranium of AMNH 19925, holotype of *Alphestes scholanderi*. Standard length 760 mm.

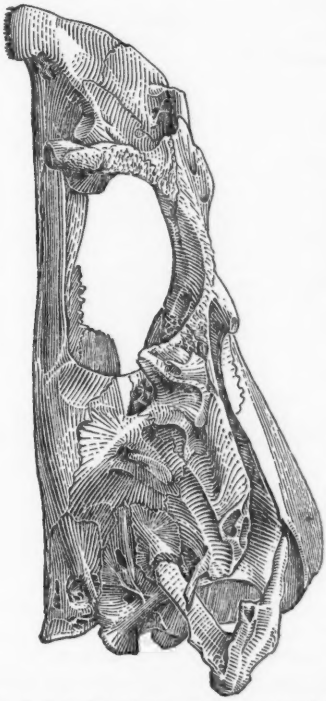


Fig. 3. Left lateral aspect of neurocranium of AMNH 19925.

narrow, wavy, vertical, dark bands on the sides, a broad dark band across the lower part of the opercle and another across the preopercle.

DIAGNOSIS.—There is a close resemblance to the genus *Epinephelus* but the presence of the small antrorse spine on the rear of the lower limb of the preopercle and the morphology of the parietal crests indicate that this species actually belongs in *Alphestes*, as the genera are currently defined. Three other species of *Alphestes* are known, all small fishes which probably do not exceed 300 mm. in standard length (the smallest *A. scholanderi*, AMNH 19924, measured 750 mm.). Two, *A. multiguttatus* (Günther) and *A. galapagensis* Fowler, are found in the Pacific. The third, *A. afer* (Bloch) is found in the Atlantic north to Dry Tortugas, Fla. and Bermuda. *Alphestes scholanderi* is considerably larger than the other species but the characters in the following table will probably serve to distinguish large and small individuals of the new species from other forms of the genus.

Unless the neurocranium is examined the new species might easily be mistaken for either

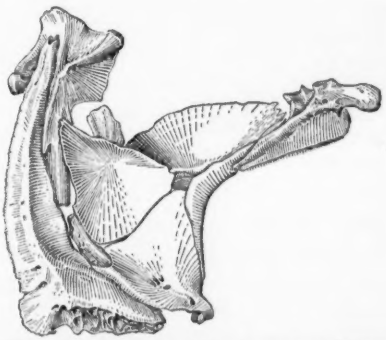


Fig. 4. Lateral aspect of left preopercle of AMNH 19925, showing the small antrorse spine on the lower limb near the angle.

TABLE 1

Alphestes scholanderi, sp. nov.	Other species of *Alphestes*
1. Dorsal rays 13–14.	Dorsal rays 17–20.
2. Upper preopercular limb vertical, notched.	Upper preopercular limb oblique, without notch.
3. Second or third dorsal spine highest, fifth spine shorter than fourth or sixth, spinous portion of dorsal fin appears subdivided between spines 3 and 4 when the fin is erect.	Fourth or fifth dorsal spine highest, following spines gradually diminish in height, spinous portion of dorsal fin does not appear to be subdivided when the fin is erect.
4. Maxillary scaled.	Maxillary naked.
5. Maxillary ends beneath pupil.	Maxillary ends beneath or behind rear of eye.
6. Second anal spine 0.6–0.8 as long as third.	Second anal spine about as long as third.
7. Posterior nostril 2.1–3.7 times diameter of anterior nostril.	Anterior and posterior nostrils subequal.
8. Body scales ctenoid.	Most body scales cycloid; scales ctenoid in forward half of body below lateral line.

Epinephelus morio or *E. mystacinus* since the posterior nostril is much larger than the anterior (*E. mystacinus*) and the second dorsal spine almost equals or exceeds the third in length (*E. morio*). In *E. morio* and *E. mystacinus*, however, the fifth dorsal spine is not shorter than the fourth and sixth spines (it is shorter in *A. scholanderi*) and the spinous portion of the dorsal fin is not subdivided (it is subdivided in *A. scholanderi*).

NOTES.—Pending a thorough revision of the epinepheline fishes it is felt best to regard the new species as a form of *Alphestes*. It has been referred to in the literature as *Epinephelus*, Grouper by Scholander and van Dam (1953); as *Alphestes* sp., Golden Grouper by Scholander and van Dam (1954) and by Walters (1955); and as *Alphestes* by Scholander (1954). The holotype of *A. scholanderi* measured 760 mm. in standard length before being skeletonized, and weighed 25 lbs. when it was caught. The holotype was a female and contained a mummified *Ophichthus ocellatus* in its coelomic cavity (Walters, 1955). One of the paratypes (AMNH 19924, 750 mm. long) was filleted at Bimini and the remainder was preserved; the flesh was delicious. The Golden Grouper is thus far known only from deep water (1224 to 1500 feet) west of Bimini, Bahamas and apparently does not enter shallow water because none of the natives recognized the fish when the holotype was brought ashore. The new species is named in honor of Dr. Per F. Scholander, now at the Institute of Zoophysiology, University of Oslo, Norway.

LITERATURE CITED

SCHOLANDER, P. F. 1954 Secretion of gases against high pressures in the swimbladder of deep sea fishes. II. The rete mirabile. Biol. Bull., *107* (2): 260–77.

——— AND L. VAN DAM. 1953 Composition of the swimbladder gas in deep sea fishes. Biol. Bull., *104* (1): 75–86.

———, AND ———. 1954 Secretion of gases against high pressures in the swimbladder of deep sea fishes. I. Oxygen dissociation in blood. Biol. Bull., *107* (2): 247–59.

WALTERS, V. 1955 Snake-eels as pseudoparasites of fishes. Copeia (*2*): 146–47.

THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK 24, NEW YORK

Phases of the Life History of the Rosyface Shiner, *Notropis rubellus*, in Northwestern Pennsylvania[1]

ROGER J. REED

THE life history of the rosyface shiner, *Notropis rubellus* (Agassiz) was investigated by Pfeiffer (1955). His observations were made on Five Mile Creek, Cattaraugus County, New York. The present author was able to gather additional data on this interesting cyprinid while conducting research at the University of Pittsburgh's Laboratory of Field Biology, Linesville, Pennsylvania; some of these data have already been published (Reed, 1954; 1955).

[1]This paper is part of a thesis submitted to the Department of Biological Sciences of the University of Pittsburgh in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June, 1956.

Materials and Methods

In all, 5516 specimens of *N. rubellus* were examined. Of the adults, 3016 were used in the determination of age classes, growth rate and sex ratios; another 1650 for stomach analyses; and an additional 600, taken in May, to determine the percentage of feeding individuals at that time. In the sampling of immatures for their feeding preferences, twenty-five specimens were collected in each of ten samples.

All *N. rubellus* were collected with a 10 x 4 foot (¼ inch) "Common Sense" seine. Identification of stomach contents and the reading of scales were accomplished with the aid of a Spencer microscope and dissecting microscope.

Description of Habitat

Industrial pollution of streams in western Pennsylvania limits the distribution of the rosyface shiner to the northwestern section of the state. Within this region *N. rubellus* can be readily collected from the riffle habitat, where it shows a preference for the lower part of this ecological niche. Small schools could be observed swimming over the entire riffle during the low water period of late summer, but the main school was normally found in the basal region. From June 17, 1953 until June 9, 1954 specimens were collected in the following twelve streams: Slippery Rock Creek, Wolf Cr., Taylor Run, Thompson's Run, Woodcock Cr., Little Sugar Cr., Conewango Cr., Big Brokenstraw Cr., Kinzua Cr., Conneaut Cr., French Creek and the Allegheny River. The riffles of these glaciated streams are characterized by a heavy deposition of rocky rubble which affords protection and/or a source of attachment for plant and animal life. The fishes living in a typical riffle habitat on French Creek have been listed by Lachner et al. (1950).

Feeding Behavior

From June 17, 1953 to June 9, 1954 a record was kept of the number of empty stomachs in each of the thirty-three samples taken during that period. Fifty adult *N. rubellus* were collected at each sample. The graph, Fig. 1, depicts the percentage of "full stomachs", i.e., stomachs with some food in them, at each biweekly sample and can be used as a criterion of the yearly feeding activity of the rosyface shiner. From November 19, 1953 until March 19, 1954 all stomachs were empty. These dates can be correlated with the migratory behavior uncovered for the rosyface in northwestern Pennsylvania. In mid-November of 1953 and 1954 the rosyface shiner was found to leave the riffle habitat for the deeper pools and eddies, returning to its original station by mid-March of 1954 and 1955. Figure 1 also shows a general increase in feeding activity prior to the spawning period of late May. The rosyface was found to feed only to a limited extent at the time of spawning (5.5% with some food in their stomachs; based upon the 600 spawning *rubellus* sampled).

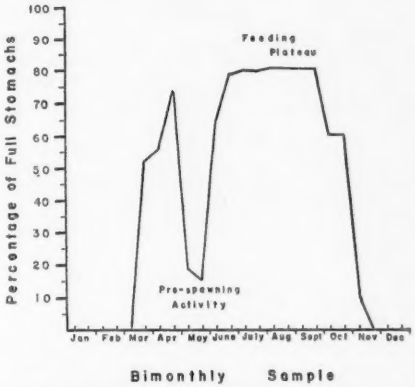


Fig. 1. The percentage of full stomachs found in adult rosyface shiners during the period of June 17, 1953 to June 9, 1954 from twelve streams in northwestern Pennsylvania.

Food Preferences

The material present in each of the 1650 adult rosyface stomachs was broken down into six categories: algae and diatoms, caddis fly larvae, may fly nymphs, diptera, other insecta and inorganic material (Table 1). Although the stomach contents were arranged into these six general headings, the material was further classified into either families or genera wherever possible. There was no attempt made to calculate the percentages of the separate families and/or genera.

Flood conditions from December 1, 1953 until February 13, 1954 in the selected streams made it impossible to collect the rosyface for stomach analysis. The fifty specimens collected on November 19, 1953 had no food in their stomachs. This condition was also true for the

TABLE 1

FREQUENCY OF OCCURRENCE OF CATEGORIES OF MATERIAL IN STOMACH CONTENTS OF 1650 ADULTS OF *N. rubellus* COLLECTED FROM TWELVE STREAMS IN NORTHWESTERN PENNSYLVANIA, JUNE, 1953 TO JUNE, 1954

Month of sample	No. of stomachs	Algae diatoms	Caddis flies	May flies	Diptera	Other insecta	Inorganic *
		%	%	%	%	%	%
1953							
June	150	26.9	19.8	14.7	21.6	12.5	4.5
July	200	16.1	26.0	18.7	19.5	15.9	3.8
August	200	20.1	21.9	13.2	14.1	18.6	12.1
September	100	36.7	13.5	7.6	6.8	22.6	12.8
October	100	21.9	13.7	14.0	16.0	20.3	14.1
November	100	17.6	22.3	21.3	12.3	12.0	14.5
1954							
February	100	—	—	—	—	—	—
March	200	—	30.4	10.9	30.8	16.9	11.0
April	200	7.0	30.8	18.3	23.6	6.6	13.7
May	200	17.0	36.1	12.2	11.8	13.9	9.0
June	100	18.1	22.3	19.3	16.2	19.6	4.5
Mean		18.1	23.7	15.0	17.3	15.9	10.0

* "Bark, leaves, and sand were included in this category"

samples taken on February 19 and 27 and on March 5 and 12, 1954. The first sample in 1954 which contained any food in the stomachs was collected on March 19, 1954.

The information obtained from the yearly stomach analysis shows that the rosyface shiner is an omnivorous species: a mean of 18.1% algae and diatoms was eaten with 71.9% insect life and 10.0% inorganic material. Among insects, caddis fly larvae were most frequently eaten (23.7%). The caddis cases helped to increase the percentage of inorganic material present in the stomach. The material used by the caddis fly larvae in its construction of the case included leaves, sand and bark. Pfeiffer (1955) reported that "insects comprise 91 per cent of the total volume of food items."

Two hundred and fifty rosyface young of the year, 22 to 30 millimeters long, were sampled from July 16, 1954 until October 29, 1954 to determine their feeding preferences. Table 2 shows the comparison between the juvenile feeding habits and those of the adult during the same time range in 1953. It established that the juveniles prefer algae and diatoms (65.5%) to the insect life (28.2%) at this stage in their development. This is almost a complete reversal from the adult feeding percentages (algae and diatoms 22.4%—insect life 68.4%).

TABLE 2

STOMACH CONTENTS OF *N. rubellus* COLLECTED FROM FRENCH CREEK

Date of sample	No. of specimens	Algae diatoms	Caddis flies	May flies	Diptera	Other insecta	Inorganic
		%	%	%	%	%	%
Young, 22–30 mm.							
7-16-54	25	77.9	—	—	16.0	—	6.1
7-22-54	25	77.7	—	—	15.0	—	7.3
7-27-54	25	79.4	8.0	2.0	2.9	—	7.7
8-3-54	25	71.7	7.8	10.1	2.6	—	7.8
8-10-54	25	76.5	2.8	10.0	3.0	—	7.7
8-17-54	25	74.7	5.7	10.0	3.0	—	6.6
9-11-54	25	63.4	8.9	11.0	4.9	6.5	5.3
9-25-54	25	53.2	13.8	12.7	9.0	6.0	5.3
10-11-54	25	41.3	14.0	11.3	13.9	15.5	4.0
10-25-54	25	39.3	18.4	12.6	12.8	11.5	5.4
Mean		65.5	8.0	8.0	8.3	3.9	6.3
Adults							
7-13-53	50	25.7	23.7	16.4	16.4	13.8	4.4
7-20-53	50	12.1	29.4	22.4	16.3	16.2	3.6
7-29-53	50	11.2	27.2	19.3	26.6	12.8	2.9
8-3-53	50	15.8	22.1	19.1	19.9	19.1	4.0
8-10-53	50	17.1	27.5	11.3	17.1	21.0	6.0
8-17-53	50	20.0	23.1	16.8	13.0	14.0	13.1
8-24-53	50	27.5	14.8	9.6	10.4	24.5	13.2
9-10-53	50	39.7	14.7	4.6	5.4	22.8	12.8
9-26-53	50	33.7	12.3	10.3	10.3	22.5	12.9
10-12-53	50	16.8	11.4	15.8	17.2	24.0	14.8
10-24-53	50	27.1	16.0	12.1	14.7	16.5	13.6
Mean		22.4	20.2	14.3	15.1	18.8	9.2

GROWTH RATE AND SEX RATIO

The scale reading method, as described by Creaser (1926) and Lagler (1947), was employed in determining the age of 3016 adult *rubellus*. Scales were taken from the mid-side of the body above the lateral line, cleaned and placed in a watch glass containing water and examined with the aid of a dissecting microscope for annular rings.

Like Pfeiffer (1955: 101) I found the life span of the rosyface shiner to be three years

TABLE 3

LENGTH FREQUENCIES AND SEX RATIOS FOR EACH AGE CLASS OF *Notropis rubellus* COLLECTED FROM TWELVE STREAMS IN NORTHWESTERN PENNSYLVANIA DURING JUNE 17, 1953 TO JUNE 9, 1954

Standard length in millimeters	Age Class 1		2		3		Totals for all age classes		
	♂	♀	♂	♀	♂	♀	♂	♀	(♂ + ♀)
38	2	1					2	1	3
40	3	3					3	3	6
42	10	8					10	8	18
44	21	19					21	19	40
46	87	52					87	52	139
48	190	139					190	139	329
50	349	276	1				350	276	626
52	277	241	4	2			281	243	524
54	153	134	15	7			168	141	309
56	47	86	54	38			101	124	225
58	5	16	119	75	1		125	91	216
60	2	3	128	100	3	1	133	104	237
62			42	86	6	3	48	89	137
64			23	55	16	5	39	60	99
66			6	11	11	15	17	26	43
68			1	1	4	23	5	24	29
70					5	12	5	12	17
72					—	9	—	9	9
74					2	3	2	3	5
76					2	2	2	2	4
78					—	1	—	1	1
Total	1146	978	393	375	50	74	1589	1427	3016
Mean length	50.4	51.9	59.1	60.3	65.6	68.4			

with the females attaining a somewhat greater size than the males, (Table 3).

From the data obtained in the tabulation of length frequencies and sex ratios, the chi-square test to determine possible significant departure from a 1 to 1 sex ratio was calculated (Table 4). The test showed significant differences in the first and third year age class. There was no significance in the second year sex ratio. The males show a decrease in numbers in the older age groups. The interpretation of this information follows the same general conclusions reached by Lachner, *et al.* (1950): that sex ratio may vary with increased age or be variably represented in different segments of the same population. Since Lachner's observations were limited to darter populations on a single riffle of French Creek, there is a possibility that variation within a population would be significant. However, over a wide area and sampling of many *rubellus* populations this factor would tend to be eliminated.

TABLE 4

THE PROBABILITY FOR VALUES OF CHI-SQUARE THAT A SIGNIFICANT DEPARTURE FROM A 1 TO 1 SEX RATIO OCCURRED IN 3016 *Notropis rubellus* COLLECTED FROM TWELVE STREAMS IN NORTHWESTERN PENNSYLVANIA

Age class	Sex	Sex ratio M-F	Observed frequencies	Theoretical frequencies	Chi-Square	Probability
1	♂	1.17:1	1146	1062	13.28*	.01
	♀		978	1062		
2	♂	1.04:1	393	384	.44	.50–.70
	♀		375	384		
3	♂	.68:1	50	62	4.64†	.05–.02
	♀		74	62		

* Highly significant at the 1% level of confidence departure from the 1 to 1 ratio.
† Significant at the 5% level of confidence departure from the 1 to 1 ratio.

SUMMARY AND ACKNOWLEDGMENTS

Field observations and collections were obtained from twelve streams of the Ohio and Lake Erie drainages in northwestern Pennsylvania.

A preference for the basal portion of the riffle habitat during early spring, through the summer and into the fall was uncovered for this species. There is a migration from the riffle habitat into the deeper pools and eddies in the fall, with return to the riffles by mid-March.

The rosyface shiner was omnivorous during the period of June 17, 1953 to June 9, 1954. The adults fed upon algae and diatoms (18.1%), insects (71.9%) and inorganic material (10.0%). Caddis fly larvae were the most important insects eaten (23.7%).

The empty stomachs found in each sample taken during a one year period was recorded and used as a criterion of seasonal feeding activity. The young of the year were also sampled for their food preference. The stomach analysis showed a reversal in food preferences as compared to the adults during the same period; algae and diatoms (65.5%) and insects (28.7%).

The life span of the rosyface in the area investigated is three years as determined by the scale reading method. The female attained the greatest mean growth during the three years (68.4 millimeters).

The chi-square test established that a significant departure occurred from the 1 to 1

sex ratio in the first and third year class. The males showed a decrease in numbers in the older age groups.

The author wishes to express his gratitude to Doctor C. A. Tryon of the University of Pittsburgh for his guidance throughout this investigation. He is indebted to Doctor Richard Hartman and Doctor Ralph Priddy of the University for their assistance in the identification of the plant and insect life. The author also wishes to thank Doctor Gloria Borecky of the University of Pittsburgh's Johnstown Center, for a helping hand in the difficult task of seining.

Literature Cited

Creaser, C. W. 1926. The structure and growth of the scales of fishes in relation to the interpretation of their life history; with special reference to the sunfish, *Eupomotis gibbosus*. Misc. Publ. Univ. Mich. Mus. Zool., *17*: 1–82.

Lachner, E. A., Edward F. Westlake and Paul S. Handwerk. 1950 Studies on the biology of some percid fishes from western Pennsylvania. Amer. Midl. Nat., *43* (1): 92–111.

Lagler, K. F. 1947. Lepidological Studies I. Scale characters of the families of Great Lakes fishes. Trans. Amer. Micro. Soc. *66* (2): 149–171.

Pfeiffer, R. A. 1955. Studies on the life history of the rosyface shiner, *Notropis rubellus* (Agassiz). Copeia (*2*): 95–104.

Reed, R. J. 1954. Hermaphroditism in the rosyface shiner, *Notropis rubellus* (Agassiz). Ibid., (*4*): 293–294.

——— 1955. Occurrence of the white liver grub, *Posthodiplostomum minimum*, in fishes of Slippery Rock Creek, Pennsylvania. Ibid., (*3*): 240–241.

Pennsylvania Fish Commission, Conneautville, Pennsylvania.

Characteristics and Fertility of Experimentally Produced Sunfish Hybrids, *Lepomis gibbosus* × *L. macrochirus*

Karl F. Lagler and Charles Steinmetz, Jr.

HYBRID sunfish utilized in this study were obtained by mating pumpkinseeds (*Lepomis gibbosus*) and bluegills (*L. macrochirus*) under controlled conditions in 1949. The parents were seined from natural waters in Washtenaw County, Michigan. For the crosses, only ripe adults were employed which appeared to be typical of the two species; these were crossed in small ponds that had no sunfishes in them. One of these ponds was newly constructed, isolated from other surface waters, and contained only stocked gambusias. The other was treated with rotenone to remove resident fishes before being placed in hybrid production. It had no surface-water inlet and its outlet was effectively dammed and screened to prevent fish ingress. Both of the ponds were less than 0.1 acre in area and were near Ann Arbor, in Washtenaw County, Michigan. No sunfish was used as a parent unless its sex could be identified positively by pressing eggs or milt from it. Males of one species and females of the other species were stocked in one of the ponds. The reciprocal cross was made in the other. Between 24 and 30 members were used of each sex of both species. Both kinds of matings produced an abundance of young.

Hybrid young were stocked along with largemouth bass (*Micropterus salmoides*) in newly constructed (1948) Lake Naomi near Mundelein, Illinois. This private body of water had a 15-foot dam barring entry of fish from its downstream drainage. It had no tributary and was filled by surface run-off in the spring of 1949. Sixteen hundred young of the experimentally produced F_1 sunfish were put in Lake Naomi on November 7, 1949. On July 1, 1950, 850 additional yearlings were planted. Samples of the stocked hybrids were taken in September, 1950 (12 specimens) and in June and September of 1952 (14 and 8 individuals, respectively). Application of the scale method of age assessment gave positive identity to the filial generation of each of these specimens.

Fertility of the F_1 Hybrid

That F_1 sunfish hybrids might be fertile was first suggested by Ricker (1948) who interbred hybrids resulting from the cross *Lepomis macrochirus* × *L. microlophus*. Hubbs and Hubbs

(1933) had concluded earlier that hybrid sunfish were apparently sterile, and Hubbs (1955) later reiterated this belief.

F_1 hybrids of the combination *Lepomis gibbosus* × *L. macrochirus* proved to be interfertile. The first suggestion of reproductive capacity in individuals of this cross appeared when yearling males excavated nests in Lake Naomi in 1950. Final proof of the fertility of these fish was furnished by analysis of the size distribution and of the scales of specimens taken in September, 1952, three years after planting. In this lot both two- and three-year-old fish were present along with younger ones. The three-year-old specimens represented the F_1 constituting the original plant; the two-year-old ones were F_2 hybrids. The zero- and the one-year-old fish taken at the same time may have been either F_3 or the back-cross result of F_2 × F_1 individuals. Material of the latter two kinds was not analyzed for character behavior because there was no way of being positive of their parentage, and the specimens were small in size and number.

Characters of F_1 Compared with Those of Parent Species-stocks

Until the present time no detailed statistical comparison of known F_1 hybrid sunfish of the pumpkinseed by bluegill cross and of the parental species-stocks has been made. The analysis by Bailey and Lagler (1938) of wild fish was based on the assumptions that the hybrid populations were composed of F_1 individuals and that the parental individuals were "pure" species stocks. The first of these assumptions was founded on the supposed infertility of hybrid sunfishes (Hubbs and Hubbs, 1933) and on their earlier (1932) demonstration that hybridization was possible. However, the first filial generations of two such crosses in nature (which also occur) are now known to be capable of producing offspring: Ricker (1948) claimed fertility of the F_1 hybrid *Lepomis macrochirus* × *L. microlophus*, and the present study reports it for *Lepomis gibbosus* × *L. macrochirus*. Therefore, the wild caught individuals presumed to be F_1 by Hubbs and Hubbs (1931), Bailey and Lagler (1938), and others may have included also individuals of successive filial generations or offspring of their backcrosses to parental species.

Because actual parent specimens had not been saved, we compared F_1 hybrids with representatives of the parent species. This procedure was based on the assumption that the actual parents and the representatives studied in their stead were not importantly different.

The range in standard length (mm.) of the museum specimens and the hybrids with which certain of their characteristics were compared was as follows: 25 pumpkinseeds, 89 to 175, mean 124; 25 bluegills, 104 to 183, mean 122; 29 F_1 hybrids, 48 to 179, mean 121; 3 F_2 hybrids, 100 to 133, mean 119.

Our findings support the conclusions of Bailey and Lagler (1938) on hybrid intermediacy as follows: (1) the opercle of the F_1 hybrid was semiflexible, that is, increased in rigidity over *L. macrochirus*, but less rigid than in *L. gibbosus*; (2) the F_1 hybrid had a smaller and more dilute reddish spot than the pumpkinseed on the opercular membrane; (3) the F_1 hybrid had a diffuse dark spot (not as dark as in *L. macrochirus*) on the dorsal fin membranes (but not on the fin rays); (4) pharyngeal arch and tooth form were also apparently intermediate. In addition, intermediacy was shown by (1) the length of the gillraker at the angle of the last gill arch when divided by the standard length; (2) head length divided by length of longest anal spine.

The previous characters have subjective elements in their appraisal or mensuration. Certain counts afford more objective evaluation than the foregoing although meristic differences between the parental species are very small and numerically our samples are weak. Nevertheless, F_1 intermediacy was shown by the means for: (1) anal soft-ray count; (2) pectoral fin rays; (3) cheek scales; and (4) lateral line scales.

Mean values for certain hybrid characters were found to be non-intermediate between those of representatives of the parent species, as follows: (1) number of dorsal spines, lower in F_1 than in either parental species; (2) number of dorsal soft rays (posterior ray always considered double at base), a little higher than both parental species; and (3) standard length/upper jaw length (tip of snout to posterior tip

of maxillary), lower for F_1 (and F_2) than for both parents.

Thus on the basis of work to date, there is no clear-cut evidence that field caught hybrids are different from experimentally produced ones.

Use of Hybrid Sunfish in Fishery Management

A common species combination in the stocking of growing numbers of farm ponds in America is largemouth bass and bluegill. A difficulty subsequently encountered repeatedly is over-population by the sunfish leading to retarded growth. In addition, the largemouth bass, relatively ineffectual as a predator, may even be squeezed from the population. Prior to the discovery of interfertility of some sunfish hybrids, there was brighter hope than now of maintaining desired population balance by using hybrids for stocking, as suggested by Ricker (1948). In fact, it was this hope which led to the production of the F_1 sunfish hybrids reported here. On the basis of the apparently high degree of fertility in the pumpkinseed-bluegill cross as evidenced in Lake Naomi, however, utilitarian possibility seems lessened. Other possible species crosses, should, however, be tried. One of promise might involve the green sunfish (*L. cyanellus*) which has the largest mouth (and thus, perhaps, the greatest predatory capacity) of the fishes of its genus. Another would be to use intergeneric hybrids within the family. Some beneficial reduction in reproductive potential may exist in the predominence of males in hybrid offspring as pointed out by Hubbs and Hubbs (1933) and shown by percentage males of 75 and 100 in our two hybrid samples.

Field experiments reported here were supported by the public service branch of Associated Fishing Tackle Manufacturers (now the Sport Fishing Institute). Lake Naomi was provided by owner Leo Burnett of Libertyville, Illinois. Many friends and colleagues helped us, especially Robert O. Beatty and Robert C. Gibbs. Frederick E. Smith, Reeve M. Bailey, William A. Gosline, and Robert R. Miller gave suggestions for improvement of the manuscript. Field experiments and the laboratory analyses were conducted and/or supervised by Lagler. Counts and measurements were made by Steinmetz and appear in his Master's thesis (University of Michigan Libraries, 1955: An Analysis of Experimentally Produced Sunfish Hybrids, *Lepomis: gibbosus* × *macrochirus*).

Literature Cited

Bailey, Reeve M., and Karl F. Lagler. 1938. An analysis of hybridization in a population of stunted sunfishes in New York. *Pap. Mich. Acad. Sci., Arts, and Letters, 23* (1937): 577–606, 5 figs.

Hubbs, Carl L. 1955. Hybridization between fish species in nature. Syst. Zool., 4 (*1*): 1–20, 8 figs.

———, and Laura C. Hubbs. 1931. Increased growth in hybrid sunfishes. *Pap. Mich. Acad. Sci., Arts, and Letters*, 13 (1930): 291–301, 2 figs.

———, and ———. 1932. Experimental verification of natural hybridization between distinct genera of sunfishes. *Pap. Mich. Acad. Sci., Arts, and Letters, 15* (*1931*): 427–437.

———, and ——— 1933. The increased growth, predominant maleness, and apparent infertility of hybrid sunfishes. *Pap. Mich. Acad. Sci., Arts, and Letters, 17* (*1932*): *613–641, 3 figs.*

Ricker, William E. 1948. Hybrid sunfish for stocking small ponds. *Trans. Amer. Fish. Soc., 75* (*1945*): *84–96.*

Department of Fisheries, University of Michigan, Ann Arbor, Michigan.

Filter Paper Electrophoresis of Serum Proteins from Sharks

Theodore J. Starr and Walter Fosberg

Various investigators have shown that electrophoretic techniques (McDonald, 1955) are well suited for characterization of serum protein abnormalities in man (Mackay and Volwiler, 1954) and in cattle (Bradish *et al.*, 1954). However, it is difficult to find a basis of comparison of blood protein patterns found by research groups using different apparatus and procedures (Deutsch and Goodloe, 1945; Moore, 1945; and Deutsch and McShan, 1949).

These investigators used the Tiselius-type electrophoretic apparatus (Taylor, 1953) to examine sera and plasma proteins of various mammals, birds, and vertebrates. They showed that the characteristic pattern of each species is reproducible and that the differences between species, in respect to both quantity and presence or absence of components, is significant. In addition they emphasized that only patterns obtained under similar experimental conditions were comparable.

Recently, Cremer and Tiselius (1950) have shown that the components of serum protein could be separated effectively by filter paper electrophoresis. Some advantages of filter paper electrophoresis over the Tiselius methods are the smaller sample required, lower cost of equipment, and ease of use. Gleason and Friedberg (1953) used filter paper apparatus to examine the serum proteins of small animals. Drilhon (1953) examined two eels, a carp, and a dogfish. Dessauer and Fox (1956) examined about 1200 plasma protein patterns of members of the orders *Amphibia* and *Reptilia*.

In this investigation the blood serum protein patterns of four species of sharks were studied using paper electrophoretic techniques. It is hoped that further studies along these lines will be of value as a phylogenetic tool and for comparative biochemical studies of marine organisms.

Methods

Six male sharks were caught August, 1956 with a seine in the Gulf of Mexico along the shore of Galveston, Texas. The sharks were identified (Tee-van, 1948) by Mr. E. L. Arnold of this laboratory. They represented two specimens of *Scoliodon terrae-novae* or sharp-nosed shark, each 15 in. total length; two specimens of *Aprinodon isodon*, each 19 in. total length; one specimen of *Sphyrna diplana* or hammerhead shark, 18 in. total length; and one specimen of *Sphyrna tiburo* or bonnet-head shark, 19 in. total length. The fish were brought to the laboratory within one hour and appeared dead on arrival. Their hearts were exposed (all were beating) and cardiac punctures were made with glass pipets. Only one puncture was made per fish in order to avoid dilution of each blood sample with body fluids. Approximately 2 to 5 ml. of blood from each shark were placed into separate test tubes. After several hr. at room temperature (24°C–26°C), the expressed serum was removed from the clot by decanting. Serum samples were centrifuged at 8,000 rpm at 4°C. for 5 min. Aliquots of the straw-yellow sera were analyzed immediately.

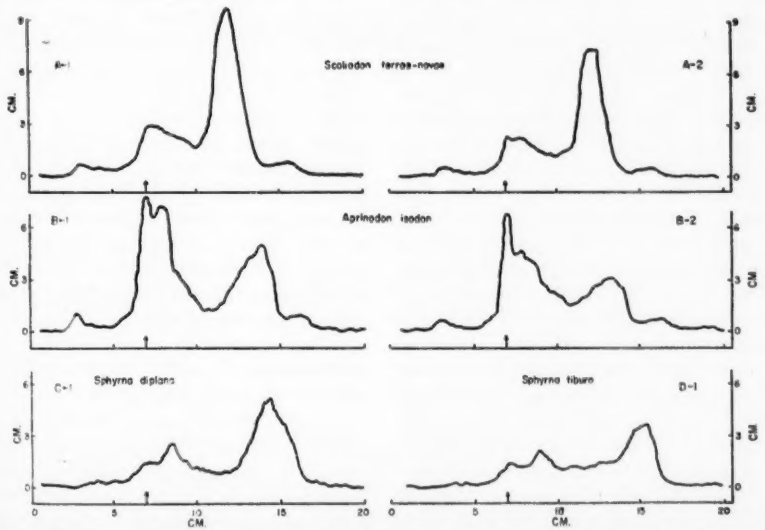


Fig. 1. Filter paper electrophoretic patterns of shark serum samples. Arrow indicates starting line.

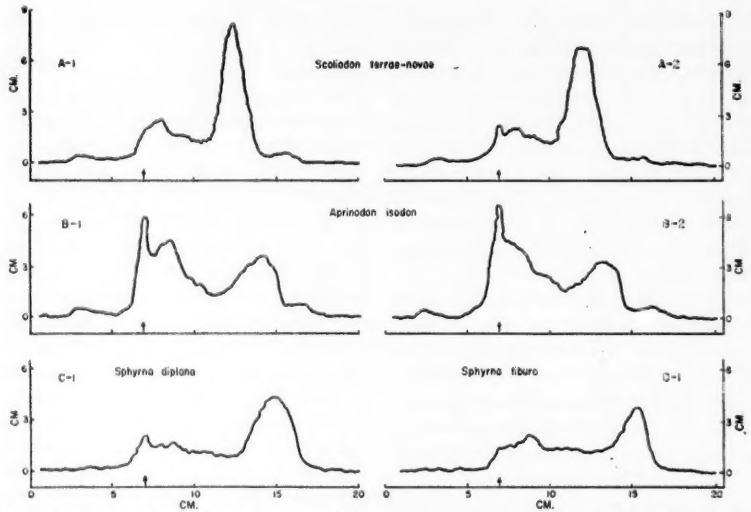


Fig. 2. Filter paper electrophoretic patterns of the same serum samples shown in Figure 1 but analyzed after one week storage in a deep freeze.

The Spinco Model R Analytrol and Duostat were used in these experiments. The general operating instructions recommended for the analysis of human sera with this equipment were followed. We used the recommended Spinco Buffer B-2 (2.76 gm. diethyl barbituric acid and 15.40 gm. sodium diethyl barbiturate per 1000 ml. distilled water) at pH 8.6 and ionic strength of 0.075. One liter of this buffer was placed into each of two electrophoresis cells with a capacity of eight paper strips each. The paper strips were saturated with buffer. After a 30 to 40 min. equilibrium period, 0.02 ml. of each undiluted sample was applied to separate paper strips with a striper which was filled with a micropipette. A constant current of 12 milliamperes (at 115 volts) was applied for 19 hr. at room temperature (24°C–26°C). The paper strips were then dried in an oven for 30 min. at 120°C. After immersing the dried strips in Spinco Dye B-1 (0.1 gm. bromphenol blue dissolved in 50 ml. of 95 per cent ethyl alcohol plus 31 gm. zinc sulphate and made to 1000 ml. with 5 percent acetic acid) for 6 hr., the strips were rinsed twice in 1000 ml. of 5 per cent acetic acid for 6 min. periods. The paper strips were then fixed in Spinco Fixative B-2 (9.0 gm. sodium acetate dissolved in 1000 ml. of 10 per cent acetic acid) for 6 min. After blotting, the stained strips were dried in a preheated oven at 120°C for 15 min. and subsequently scanned with the analytrol.

Results and Discussion

The serum protein patterns obtained from the dyed paper strips with the analytrol are shown in Figure 1. The majority of components migrated toward the anode (right of the arrow). The sera of *Scoliodon* and *Aprinodon* contain one component which moved toward the cathode (left of the arrow). This component is hardly noticeable in samples of the two *Sphyrna* species. Patterns are similar between different individuals of the same species (A-1 and A-2, B-1 and B-2). However, significant quantitative differences are evident between members of the three genera as shown by the presence or absence, relative concentrations, mobility, and direction of migration of the different components. Comparison of the patterns of the two *Sphyrna* species (C-1 and D-1) shows the lesser amount of variation between different species of the same genus.

The key in Fishes of the Western North Atlantic (Tee-van, 1948) places all four genera within the suborder *Galeoidea*; the genera *Scoliodon* and *Aprinodon* are in the family *Carcharhinidae*; and the genus *Sphyrna* is in the family *Sphyrnidae*.

The same serum samples were reanalyzed (Fig. 2) after one week storage in a deep-freeze. Comparison of Figures 1 and 2 shows the minor differences that resulted and the reproducibility of the patterns by the techniques used.

The data presented in this preliminary report should be interpreted with caution. Moore (1945) studied sera patterns of rats, cats, chick and pig embryos. He showed major changes in serum patterns with age and development. He advanced the possibility that sera from the same species living under different conditions might present a pattern different from the one considered typical. Dessauer and Fox (1956) studied the plasma patterns among members of the order *Amphibia* and *Reptilia*. They found differences in patterns due to sex, age, starvation, season, and geographic variation.

Literature Cited

Bradish, C. J., W. M. Henderson, and J. B. Brooksby. 1954. Electrophoretic studies of ox serum. 1. The sera of normal cattle. *Biochem. Jour., 56: 329–35.*

Cremer, H. D., and A. Tiselius. 1950. Electrophorese von Eiweiss in Filtrierpapier. *Biochem. Ztschr., 320: 273–83.*

Deutsch, H. F., and M. B. Goodloe. 1945. An electrophoresis survey of various animal plasmas. *Jour. Biol. Chem., 161: 1–20.*

Deutsch, H. F., and W. H. McShan. 1949. Biophysical studies of blood plasma proteins. XII. Electrophoretic studies of the blood serum proteins of some lower animals. *Jour. Biol. Chem., 180: 219–34.*

Dressauer, H. C., and W. Fox. 1956. Characteristic electrophoretic patterns of plasma proteins of orders of *Amphibia* and *Reptila*. *Science, 124: 225–6.*

Drilhon, A. 1953. Étude de quelques diagrammes électrophorétiques de plasmas de poissons. *Comptes Rendus Soc. de Biol., 237: 1779–81.*

Gleason, T. L. and F. Friedberg. 1953. Filter-paper electrophoresis of serum proteins from small animals. *Physiol. Zool., 26: 95–100.*

Mackay, I. R. and W. Volwiler. 1954. Quantitative aspects of filter paper electrophoresis of serum. *Austral. Ann. Med., 4: 263–9.*

McDonald, H. J. 1955. Ionography. *The Year Book Publishers, Inc., Chicago, 268 pp.*

Moore, D. H. 1945. Species differences in serum protein patterns. *Jour. Biol. Chem., 161: 21–32.*

Taylor, J. F. 1953. The isolation of proteins. In: H. Neurath and K. Bailey, "The Proteins", Vol. 1, Part A. *Academic Press, Inc., New York, pp. 1–85.*

Tee-van, J. 1948. Fishes of the Western North Atlantic. *Sears Foundation for Marine Research, Yale University, 576 pp.*

Gulf Fishery Investigations, U. S. Fish and Wildlife Service, Galveston, Texas.

The Reproduction and Early Development of the Sea Catfish, *Galeichthys felis*, in the Biloxi (Mississippi) Bay

J. W. Ward

Luptin (1879) reported that the male of *Galeichthys felis* practices oral gestation and that the mouth of the male is enlarged during breeding season. The above facts were later verified by Gudger (1916, 1918), Lee (1931, 1937), Merriman (1940), Gunter (1947), and others. These studies showed that the male takes the eggs soon after they have been fertilized and carries them in the enlarged mouth for 60 to 80 days, during which time development takes place. The yolk is entirely absorbed and the walls of the abdomen fuse. Lee (1931) and Gowanloch (1933) have described the enlarged spatula-like protuberance on the adaxal surface of the pelvic fin of the female during breeding season. Gunter (1947) stated that the cloacal region of the female is hemorrhagic and is partly everted during breeding season. He also stated that a micropyle is present in ovarian eggs and that long plugs of small, hyaline, non-functional eggs are attached to the functional ovarian eggs opposite the micropyle. Gunter suggested that perhaps the male eats the small non-functional eggs immediately before beginning the long fast that is necessitated by oral gestation.

The present work deals with a study of the natural history, reproduction, cleavage, and early embryology of this fish. The information is based upon observations made upon 1,465 adults and 500 "mouth young" collected chiefly from the Mississippi Sound area of the

Biloxi Bay. Early cleavage stages were obtained by means of artificial insemination. Ten developmental stages are described from the two cell stage through the 45 mm. embryo. A more detailed study of the embryology is now in progress, with special emphasis upon the development and structure of the brain and cranial nerves.

Reproduction

The adult material was collected from Davis Bay during the years 1952 through 1956 from early March until mid-August. Seventy-five percent of those collected during March and April were males. There was a gradual increase of females from April until the middle of May, at which time the two sexes were about equally well represented. The largest eggs in the ovaries of adult females collected from April until the first of July could be classified into four sizes: 4 to 6 mm. in March, 6 to 8 mm. in April, 9 to 14 mm. in May, and 14 to 16 mm. in June and July.

Some of the males collected from the first of May until the first week in August carried young in the mouth. These varied in age from the "unhatched stage", in which there was no flexion and torsion of the body, to the stage in which almost all of the yolk was absorbed and the specimens possessed all of the external adult characteristics. Almost all of the developing young carried in the mouth of a given male were in the same stage of development.

Fifteen male fish were collected in a dip net during the third week of June, 1956, whose mouths and hypoglossal regions were enlarged, yet none of them carried young in their mouths. A careful but vain search was made for embryos in the net and in the tub in which the fish were transported. This would seem to lend additional proof to the belief that the mouth and hypoglossal region of the male enlarges previous to the act of taking in the fertilized eggs.

Microscopic examinations were made upon fresh testes and ovaries. The testes were teased apart with needles, after which time a slight amount of pressure was exerted on the preparation by the cover glass. Motile sperm found in the majority of males were encountered from the first of March until the middle of July. During the months of March, April, and May, the greater part of the developing ova were in the primary and secondary stages of development. During the early part of June the ova appear to go through a stage of growth and enlarge by the addition of yolk. At the same time the vascularity of the eggs increased many times. Maturity and ovulation appear to take place the latter part of June and during July. Shortly before ovulation the blood vessels disappear and the eggs take on a greenish hue.

One hundred fifty-four adult specimens were collected by hook and line during the week of June 20, 1955. Sixteen were males whose testes contained motile sperm. One hundred fifty-four were females. The ovaries of 152 females contained from 40 to 62 eggs each, the largest of which were 12 to 14 mm. in diameter. Each ovary also contained many small, non-functional, colorless eggs attached to the larger eggs, and to one another, by the tenacious glue described by Gunter. The larger eggs were covered with capillaries. In the laboratory these eggs were exposed to motile sperm for two hours. Apparently none were fertilized, for there was no indication of cleavage.

Extending from the cloaca of one female was a long plug of the small hyaline eggs described by Gunter (1947). Forty eggs, 12 to 14 mm. in diameter, of a greenish hue, and not covered with capillaries, were removed from the ovaries. The eggs, together with sperm taken from the macerated testes of a male, were placed in a bowl of sea water supplied with two aerator outlets. The eggs were left in the bowl with the sperm for two hours, after which time they were placed in sperm-free sea water. At the end of six and one-half hours, 35 of the eggs had developed to either the two cell stage or the four cell stage of cleavage. The remaining five eggs, which showed no cleavage stages, were in a container of sea water from which the aerators had been accidentally removed.

A second female with an enlarged, hemorrhagic cloacal region was observed but there was no indication of the plug of hyalinized non-functional eggs. Thirty-two eggs, measuring about 14 mm., were removed from the ovaries and were exposed to sperm in the same manner as described above. All of these eggs were fertilized and had begun to cleave after seven hours. After 23.5 hours some of these eggs were in the late cleavage stage.

Two hundred twenty-four adult specimens

were taken during the week of July 25, 1955 by cast net, dip net, and wire basket while feeding in great numbers near a shrimp cannery. Of these, 17 were immature specimens, 19 were mature males, and 188 spent females. In the mature males an enlarged hyoid region, indicating the possibility of recent oral gestation, was present in only two of the nineteen. In the spent females the enlarged spatula-like processes on the pelvic fin were present as described by Lee (1937). There was no indication of increased vascularity in the cloacal region and the cloaca was not everted. The ovaries of these females presented the typical picture of a resting ovary.

Early Development

The ovulated eggs of *Galeichthys felis* are among the largest known in the teleost fishes. They measure from 14 to 18 mm. in diameter. Due to the difficulty in securing early developmental stages, little is known about the early embryology of this form. Investigators have also had trouble in keeping the developing young fish alive in aquaria. The writer has overcome this to a certain extent by filtering the water, rinsing the eggs twice daily, and making sure that all of the accumulated debris is removed from them.

Merriman (personal communications) stated that he has not collected eggs in stages as early as the gastrula. He states, also, that there are no early stages in the Gudger collection. The following developing stages were obtained by artificial insemination as described above. The temperature of the water ranged from 29.5° C to 30.5° C.

Stage 1. Eggs developed to the two cell stage four hours after exposure to sperm.

Stage 2. Four cell stage after seven hours.

Stage 3. Eight cell stage after nine hours.

Stage 4. Sixteen cell stage after eleven hours.

Stage 5. Blastula stage after twenty hours.

Stage 6. Gastrula stage after twenty-nine hours.

Additional stages encountered during this study are as follows.

Stage 7. Fourteen eggs in the late gastrula stage were collected from the mouth of a male in June of 1953. Lightly stained whole mounts showed the presence of the germ ring and the embryonic shield. There is a well defined ectoderm and endoderm, but little or no indication of the mesoderm.

Stage 8. Eleven eggs containing embryos to 7 mm. in length were taken from the mouth of a male on June 25, 1954. The embryos were barely visible to the unaided eye. There was no macroscopic indication of blood vessels but, under low magnification, the pulsating heart, omphalomesenteric vessels, and slow circulation of blood were visible. The brain was a straight three vesicle structure with no indication of the cerebral hemispheres and cerebellum. The midbrain and the hindbrain appeared to be in the neural groove stage. The optic vesicles and olfactory placodes were visible. The embryo exhibited lateral movement of the tail and of the caudal part of the body.

Stage 9. In the ninth stage the embryos measured from 10 to 11 mm. in length. They were embedded on the yolk. There was lateral flexion and extension of the body and tail region. The pectoral fin buds were present as leaf-like structures immediately dorsal to the developing omphalomesenteric arteries. The

TABLE I

Development of Representative Young as Seen Externally

Collection date	No. in brood	Length	Development stage
6-16-53	14		Late gastrulation.
6-21-53	5	5-7 mm.	Amnion intact; embryo straight; very few blood vessels; lateral spontaneous movements; heart *not* pulsating.
6-24-52	8	9-12 mm.	Eyes visible; heart pulsating; movement in branchial region; vessels cover half of yolk.
6-26-52	11	10-15 mm.	Lateral body movements; embryo embedded in yolk; pectoral and pelvic fin buds present; anlage of cerebellum; no roof on 4th ventricle; three gill buds; no pigment except in retina.
7-16-52	16	18-24 mm.	Pigment on pectoral fin region and in retina.
6-26-53	38	23-25 mm.	Light pigmentation; amnion intact; four branchial arteries; lateral movement of body and tail; six barbels; olfactory bulbs; cerebral hemispheres; optic lobes.
7-15-52	15	38-45 mm.	All external features; opercular cartilage and membrane; pigment on entire dorsal region of head, body, tail.

pelvic fin buds were also evident. There was no indication of pigment except in the region of the retina. The vitelline vessels extended over about one-half of the yolk. The cerebral hemispheres and optic lobes (corpora bigemina) had assumed the adult shape. The cerebellum appeared as a thin flap immediately cephalic to the roofless fourth ventricle. Three pairs of gill buds were present, each containing efferent branchial vessels.

Stage 10. In embryos of this stage there was considerable pigmentation over the entire dorsal surface of the body, especially over the pectoral fin region. The embryo lay coiled upon the yolk. All six barbels were present. The blood vessels had increased in all regions of the body and completely surrounded the yolk; they were most evident in the pectoral fins and on the dorsal surface of the brain. The brain had differentiated into the five secondary divisions. The auditory placodes were evident in the region opposite the myelencephalon.

Table I contains a summary of the development of embryos, measuring from 5 mm. to 45 mm. in length, as seen externally.

Conclusions

In the Biloxi Bay region of Mississippi during 1952 through 1956 the spawning season of *Galeichthys felis* extended from the first week in May until the first week in August. The males were sexually functional from the first of March until the first of July.

Histological structure of the ovaries indicated that oogenesis began in early March and reached the peak of maturity the first part of June.

Eggs from the body cavity were artificially fertilized with the sperm of the macerated testis.

Acknowledgments

The writer expresses appreciation to Dr. Gordon Gunter and to Dr. H. H. Shoemaker for reading the manuscript and for constructive suggestions.

Literature Cited

Gowanloch, J. W. 1933. Fishes and fishing in Louisiana. La. Dept. of Conserv., New Orleans, Bull. *23:* 1–638.

Gudger, E. W. 1916. The gaff-topsail (*Felichthys felis*), a sea catfish that carries its eggs in its mouth. Zoologica, *2* (5): 123–56.

——— 1918. Oral gestation in the gaff-topsail catfish, *Felichthys* felis. Pap. Dept. of Mar. Biol., Carnegie Inst. Washington, *12* (Pub. No. 252): 25–52.

——— 1919. The ovary of *Felichthys felis*, the gaff-topsail catfish; its structure and function. Pap. Dept. of Mar. Biol., Carnegie Inst. of Washington, 13 (Pub. No. 281): 111–28.

Gunter, G. 1947. Observations on breeding of the marine catfish, *Galeichthys felis*. Copeia, (*4*): 217–23.

Lee, G. 1931. Oral gestation in the marine six-whiskered catfish, *Galeichthys felis*. Anat. Rec., *51* (1), Suppl.: 60.

——— 1937. Oral gestation in the marine catfish, *Galeichthys felis*. Copeia, (*1*): 49–56.

Lupton, N. T. 1879. On the breeding habits of the sea-catfish (*Ariopsis milberti*). Proc. U. S. Nat. Mus., *1:* 278–79.

Merriman, D. 1940. Morphological and embryological studies on two species of marine catfish, *Bagre marinus* and *Galeichthys felis*. Zoologica: New York Zoological Society, *25* (13): 221–48.

Ward, J. W. 1956. Studies on the biology of the hard head catfish, Galeichthys felis (in press). Jour. Miss. Acad. Sci., III.

University of Mississippi Medical Center, Jackson, Mississippi and the Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Ichthyological Notes

BERYX SPLENDENS LOWE IN THE GULF OF MEXICO—Two specimens of *B. splendens* have been taken by the U. S. Fish and Wildlife Service M/V OREGON in the Gulf of Mexico. One of these, 157 mm. standard length, was taken off Mobile Bay, Oregon Station 1427, 29°11′N. Lat.—88°05′W. Long., 24 Sept. 1955, depth 200 fathoms, 80 foot shrimp trawl. The other, 27 mm. standard length, was taken from the stomach of an *Alepisaurus ferox*, caught on a longline, Oregon Station 1369, 28°29′N. Lat.—88°47′ W. Long., 20 Aug. 1955.

The larger specimen, CNHM 64165, has dorsal IV, 14; anal IV, 29; pectoral 17/17; pelvics I, 11; scales in lateral line bearing tubes 74; gill rakers 18 + 1 + 6. Preorbital spine well developed. Four

specimens of *B. splendens* from Madiera, CNHM 47973–47976, 254–295 mm. standard length, were compared and no essential differences between these and the Gulf of Mexico specimen were noted in proportions. Madiera specimens had 76–82 lateral line scales bearing tubes. The numbers of fin rays and gill rakers were within the range of variation noted in the Madiera specimens.

The 27 mm. specimen has a shorter, deeper body and resembles *B. decadactylus* Cuvier. It was compared with 4 specimens of *B. decadactylus*, CNHM 47969–47972, 230–232 mm. standard length, from Madiera. However, the number of fin rays of this 27 mm. specimen are the same as the other Gulf specimen given above and is therefore identified as *B. splendens*. Many scales are missing from the lateral line so no attempt was made to count these. The preorbital spine was well developed but not proportionately larger than in the 157 mm. specimen. The first dorsal soft ray is filamentous, extending to the tip of the middle caudal rays. G. E. Maul (1954, Boll. Mus. Mun. Funchal, 7 (17): 15–17) has reported among others 5 specimens from Madiera, 70–100 mm. standard length, also from stomachs of *A. ferox*. He mentions that the 100 mm. specimen had the first dorsal soft ray almost twice as long as the standard length.

The first and only (so far as I have been able to determine) published record for this species in the Western Atlantic is given by G. B. Goode and T. H. Bean, 1895, Oceanic Ichthyology, p. 177, pl. 53, fig. 197, based on a single specimen, approximately 127 mm. standard length, trawled by the U. S. Fish Commission steamer ALBATROSS, off the coast of the southeastern United States. These authors in text give the locality Albatross Station 2415, 39°49′30″N. Lat.—74°34′45″ W. Long., depth 424 fathoms. This locality is N.E. of Cape Hatteras. C. H. Townsend, 1901, Rept. U. S. Fish Comm. for 1900, p. 398, gives Albatross Station 2415 as 30°44′00″ N. Lat.—79°26′00″W. Long., depth 440 fathoms. This locality is S.E. of Savannah, Georgia. Goode and Bean in Atlas, p. 12 as the legend for their figure of *B. splendens* give the same locality for Station 2415 as found in Townsend so it is concluded that this specimen came from off Savannah.

Beryx splendens has also been reported from the Canary Islands, Madiera, Azores, off Portugal, off Morocco, Spain, Great Britain (?), South Africa, S. Australia, New Zealand and Japan.

I am grateful to Harvey Bullis and Giles Mead of the Fish and Wildlife Service and G. E. Maul for the specimens mentioned above and to Mrs. Marion Grey for supplying an extensive list of references.—
LOREN P. WOODS, *Chicago Natural History Museum, Chicago, Illinois.*

REPRODUCTIVE BEHAVIOR OF *GAMBUSIA HETEROCHIR*—Males of *Gambusia heterochir* Hubbs have a pronounced notch in each pectoral fin. Clark Hubbs (1957, Tulane Studies in Zoology, 5: 1–16) theorized that this notch was used to steady the gonopodium during copulation. This use of the pectoral fin has now been observed repeatedly. The reproductive behavior follows the general pattern reported by Clark and Aronson (1951, Zoologica, N. Y., 36: 49–66, pls. 1–7) for *Lebistes reticulatus* (Peters) and Clark, Aronson, and Gordon (1954, Bull. Amer. Mus. Nat. Hist., 103: 139–225, pls. 1–9) for *Xiphophorus maculatus* (Gunther) and *X. helleri* Heckel. Observations on the reproductive behavior of five other species of *Gambusia* (*affinis* Baird and Girard, *senilis* Girard, *gaigei* Hubbs, *hurtadoi* Hubbs and Springer, and *alvarezi* Hubbs and Springer) also show similar patterns.

Behavior terminology follows that of Clark, Aronson, and Gordon (*loc. sit.*).

The male reproductive behavior consists of gonopodial swinging, thrusting, nipping, quivering, pecking, and copulation. All these activities except copulation have been observed in large stock tanks and small observation chambers. Copulation has been observed only in small observation chambers. Gonopodial swinging decreased as thrusting increased in a single courtship. No correlation was noted between quivering and thrusting. Copulation usually took less than one second and averaged 0.9 seconds. Following copulation, males swam around erratically, often quivering and rolling to one side or the other. This activity was noted only after copulation. Subsequently males resumed courtship and usually copulated again in intraspecific matings.

Similar to other poeciliids, females of *G. heterochir* have less pronounced reproductive patterns than males. Females do exhibit tail slapping, nipping, and occasionally will chase a too persistent male. However, such activity will not repulse sexually excited males.

Except for minor details this pattern resembles those reported by Clark and Aronson (*loc. sit.*) and Clark, Aronson, and Gordon (*loc. sit.*). Copulation is more rapid than that reported for other poeciliids; the duration of copulation averages over one second for each of the three species reported. However, copulation is more prolonged than thrusting. As virgin females may produce young after this behavior activity, we are sure that copulation has occurred.

No males of this species or the other five gambusias studied have shown reactions similar to "fear" as reported by Seal (1911, Proc. Biol. Soc. Washington 24: 92) for *G. affinis* males.

Other workers studying poeciliid behavior have

not noted the use of pectoral fins during courtship. Carl L. Hubbs (Misc. Publ., Mus. Zool., Univ. Mich., 78: 1–28, pls. 1–4) theorized that the pectoral clasper of *Xenodexia ctenolepis* Hubbs was used to steady the gonopodium during intromission. However, he did not study the use of the structure by living fish. Males of *G. heterochir* have been observed repeatedly to spread the fin at nearly 90°s to the body axis and place the gonopodium in the deep notch on the upper pectoral margin. The use of the pectoral fin was observed in each copulation when the view was not obstructed. All males appear to be ambidextrous. The pelvic fins appear to be used during copulation in a manner similar to that of other poeciliids.

In community tanks one male (occasionally several) was dominant and usually chased all other males from the female he was courting. These males can be readily recognized by their lighter colors. Dominant males of other species of *Gambusia* can be readily recognized by having more yellow pigmentation than subordinant males.

This project is supported by National Science Foundation Grant G-2214. We wish to thank Miss Gail Kaufman for permission to report her observations on the reproductive behavior of *G. senilis*, *G. gaigei*, *G. hurtadoi*, and *G. alvarezi*.—BARBARA WARBURTON, *Texas Southmost College*, CLARK HUBBS, AND DONALD W. HAGEN, *The University of Texas.*

OCCURRENCE OF YOUNG DOLPHIN, *CORYPHAENA HIPPURUS*, IN A TEXAS BAY —During the summers of 1954, 1955, and 1956, nine young dolphin *Coryphaena hippurus*, were captured in the Rockport, Texas, boat basin. The basin is protected from Aransas Bay by a sea wall and a jetty. The nearest pass to the Gulf of Mexico is Aransas Pass, approximately 15 miles from the site of capture. The summer water temperature ranges from 71° to 90° F.

All specimens were swimming near the surface and were easily caught with dip nets. Their color before capture was mottled red, orange, and gold; upon capture the colors changed rapidly, alternating blotches of blue, green, gold, red, and orange sometimes appearing as vertical stripes on the sides. In captivity the dolphin became darker, the dorsal surface dark blue, the sides gold and green, and the ventral surface pale.

The first two specimens, collected May 1, 1954, were placed in an aquarium. The smaller one (32 mm. total length) was found dead the following morning. After several days the larger one died; it measured 73 mm., having grown an estimated 5 to 10 mm. since capture. On April 21, 1955, another dolphin, about 55 mm. was captured but died in the aquarium and was eaten by another fish. On May 24, 1955, two more specimens, 36 mm. and 38 mm. in length, were taken, and a larger one was observed but not captured. The smaller fish died soon after capture, but the 38 mm. specimen lived 29 days in an aquarium and grew to 90 mm. in length. For the first few days this dolphin accepted nothing but small live fish, but it soon learned to eat small pieces of shrimp, which became its main food item. On August 29, 1955, a dolphin 42.5 mm. in length was captured in the basin. The next specimen, 35.5 in length, appeared and was captured on June 15, 1956. Two more, 51 mm. and 54 mm. in length, were taken on October 25, 1956. The salinity in the basin at this time was 40.4 parts per thousand. A tenth example, 52 mm., was captured the same day, October 25th, in the Fulton boat basin, two and one-half miles north of the Rockport basin and approximately 17½ miles from Aransas Pass.

We are grateful to Dr. Henry H. Hildebrand and Dr. Robert H. Gibbs for confirming the identifications. No previous report of the occurrence of small dolphin in a similar bay area is known to the writer; therefore the capture of these specimens and the observed growth rate is presumed to be significant. The fish are in the collection of the Marine Laboratory of the Texas Game and Fish Commission, Rockport, Texas.—PATRICIA PEW, *Texas Game and Fish Commission, Marine Laboratory, Rockport, Texas.*

A RECORD OF THE NIGHT SHARK, *HYPOPRION SIGNATUS*, FROM BIMINI, BAHAMAS.—Bigelow and Schroeder (1948, Sears Found. Marine Res., Memoir No. 1: 316–319) stated that the night shark, *Hypoprion signatus* Poey, is common along the north coast of Cuba, and that on one occasion 36 specimens were counted at the shark fishery station at Cojimar, near Havana. The only specimen from much farther north was an immature female, 935 mm. (about 3 feet) long, taken from the offing of South Carolina on October 20, 1885. No others have been reported from the east coast of the United States until recently (Springer and Thompson, Copeia, 1957 (2): 161).

Two larger specimens were reported by Bigelow and Schroeder (1948: 319) but measurements were not recorded and the locality was not given. Those two sharks were a male 2766 mm. (9 feet, 1 inch) long and a female 2270 mm. (8 feet, 5½ inches) in length.

On May 8, 1956, Mr. Daniel H. Braman of Victoria, Texas, while fishing in the deep waters of the Florida Current off North Bimini, Bahamas, caught two night sharks at a depth of about 230 fathoms as indicated by the depth recorder on his fishing yacht 'COSA'. The larger one weighed an

estimated 120 pounds and was returned to the sea without being measured; the smaller individual was brought to the Lerner Marine Laboratory for identification. Mr. Braman, an ardent angler for deep-water fishes later informed me that he had caught a total of four night sharks at about the same location during the week of May 8. All four were taken during daylight hours.

The specimen listed here was a mature male 1978 mm. (6 feet, 6 inches) long and weighed 80 pounds. The stomach was empty.

Measurements comparable to those recorded by Bigelow and Schroeder (1948: 317) are recorded here together with proportional dimensions in percent of total length. *Trunk at origin of pectoral:* breadth 210 mm., 10.6; height 200 mm., 10.1. *Snout length in front of:* outer nostrils 98 mm., 4.9; mouth 178 mm., 9.0. *Eye:* horizontal diameter 39 mm., 2.0. *Mouth:* breadth 140 mm., 7.1; height 83 mm., 4.2. *Nostrils:* distance between inner ends 101 mm., 5.1. *Gill openings:* Left side; 1st 50 mm., 2.5, 2nd 41 mm., 2.1, 3rd 65 mm., 3.3, 4th 61 mm., 3.1, 5th 46 mm., 2.3. Right side; 1st 53 mm., 2.7, 2nd 58 mm., 2.9, 3rd 64 mm., 3.2, 4th 63 mm., 3.2, 5th 47 mm., 2.4. *First dorsal fin:* vertical height 150 mm., 7.6; length of base 165 mm., 8.3. *Second dorsal fin:* vertical height 35 mm., 1.7; length of base 55 mm., 2.3. *Anal fin:* vertical height 47 mm., 2.4; length of base 57 mm., 2.9. *Caudal fin:* upper margin 502 mm., 25.4; lower anterior margin 232 mm., 11.7. *Pectoral fin:* outer margin 357 mm., 18.0; inner margin 105 mm., 5.3; distal margin 300 mm., 15.2; length of base 107 mm., 5.4. *Distance from snout to:* 1st dorsal 673 mm., 34.0; 2nd dorsal 1313 mm., 66.4; upper caudal 1518 mm., 76.7; pectoral 467 mm., 23.6; pelvics 1053 mm., 53.2; anal 1320 mm., 66.7. *Interspace between:* 1st and 2nd dorsals 485 mm., 24.5; 2nd dorsal and caudal 140 mm., 7.1; anal and caudal 120 mm., 6.1. *Distance from origin to origin of:* pectoral and pelvics 585 mm., 29.6; pelvics and anal 266 mm., 14.3.

The night shark, easily identified according to the key in Bigelow and Schroeder, is readily distinguished from other sharks in the area by its long, pointed snout and relatively small teeth. This specimen was a bluish gray above which faded to a dirty, grayish white below. There were no small, black spots scattered over the body as mentioned by Bigelow and Schroeder.—Louis A. Krumholz, *Department of Biology, University of Louisville, Louisville, Kentucky.*

AN EARLY REVIEW ARTICLE ON THE SWIM BLADDER OF FISHES.—With the advent of several important articles concerning the swim bladder of fishes, it seems worth while to bring attention to an early review of this subject. This is

Versuch
über die
Schwimmblase
der
Fische.

Im Namen
der
Linneischen Societät zu Leipzig
entworfen
von
Gotthelf Fischer.

Thatsachen stehen fest, wenn das flüchtig aufgeführte theoretische Lehrgebäude längst eingestürzt ist.
Fr. Alex. von Humboldt.

Leipzig
in Commission bey Christian Gottlieb Rabenhorst
1795.

Fig. 1. Title page of *Versuche über die Schwimmblase der Fische.*

in the form of a small book (20 cm, 80 pages, 1 plate) entitled *Versuche über die Schwimmblase der Fische* by Gotthelf Fischer (von Waldheim), 1795 (Fig. 1).

This book is composed of 3 major sections. The first is essentially an annotated literature review of 21 titles treating the swim bladder specifically or discussing it in connection with the anatomy of a specific fish. The second is concerned with the nomenclature and morphology of the swim bladder as well as its distribution among 97 species of fishes. In this section Fischer makes the still very appropriate remark that "as far as the swim bladder is concerned, each fish is an entity unto itself!" The third section is given to the possible function of the swim bladder, including some original work. In all cases the swim bladder is considered associated with hydrostatic balance of fishes. Additional functions suggested are that it may be an accessory organ of excretion, digestion, and/or respiration. Altogether, 77 titles are cited in the text ranging from Belon (1555) to Humboldt (1795). Thus, this book repre-

sents a compilation of the important references concerning the swim bladder to the end of the eighteenth century.

Gotthelf Fischer was born October 15, 1771 in the small village of Waldheim near Leipzig, Germany. He received his MD from the University of Leipzig in 1798 having done research on "the respiration of animals." For his work in Russian natural history and his activities in the Academy and Museum in Moscow, Fischer was knighted "von Waldheim". He lived in an inspired era and was acquainted with such great men as Humboldt, Freisleben, Til, Goethe, Cuvier, Lacépède, and Geoffrey. He died in Moscow on the 18th of October, 1853.—EDWARD M. NELSON, *Department of Anatomy, Stritch School of Medicine, Loyola University, Chicago, Illinois.*

MEASUREMENTS OF A LARGE SHARPNOSE MACKEREL SHARK, *ISURUS OXYRINCHUS*, FROM BIMINI, BAHAMAS.—Bigelow and Schroeder (1948, Fishes of the Western North Atlantic, Sears Found. Marine Res., Memoir No. 1: 124–133) recorded the measurements of two males of *Isurus oxyrinchus* Rafinesque; a young individual 1598 mm. (5 feet, 3 inches) long, from Ocean City, Maryland, the other a skin, with the head attached, of an adult male 2337 mm. (7 feet, 8 inches) long from Bimini, Bahamas.

A non-gravid, mature, female sharpnose mackerel shark 3023 mm. (9 feet, 11 inches) long, that weighed 632.5 pounds, was caught by Mr. James J. Sherry, Jr. of Flint, Michigan, on February 22, 1955, just off the harbor entrance at Bimini. The stomach was empty except for the mullet (*Mugil* sp.) which had been used for bait.

Measurements comparable to those listed by Bigelow and Schroeder (1948: 125) were made with the assistance of Dr. Howard E. Winn shortly after the fish was brought to dock and are recorded here along with the proportional dimensions in percent of total length. *Trunk at origin of pectoral:* breadth 345 mm., 11.4; height 380 mm., 12.6. *Snout length in front of:* outer nostrils 139 mm., 4.6; mouth 178 mm., 5.9. *Eye:* horizontal diameter 45 mm., 1.5. *Mouth:* breadth 275 mm., 9.1; height 233 mm., 7.7. *Nostrils:* distance between inner ends 130 mm., 4.0. *Labial furrow length:* upper 29 mm., 1.0; lower 25 mm., 0.8. *Gill openings:* 1st 300 mm., 9.9; 2nd 305 mm., 10.1; 3rd 285 mm., 9.4; 4th 264 mm., 8.7; 5th 317 mm., 10.5. *First dorsal fin:* vertical height 249 mm., 8.2; length of base 305 mm., 10.1. *Second dorsal fin:* vertical height 56 mm., 1.8; length of base 27 mm., 0.9. *Anal fin:* vertical height 65 mm., 2.2; length of base 30 mm., 1.0. *Caudal fin:* upper margin 609 mm., 20.1; lower anterior margin 520 mm., 17.2. *Pectoral fin:* outer margin 635 mm., 21.0; inner margin 137 mm., 4.2; distal margin 584 mm., 19.3. *Distance from snout to:* 1st dorsal 1238 mm., 41.0; 2nd dorsal 2291., 75.7; upper caudal 2648 mm., 87.5; pectoral 827 mm., 27.3; pelvics 1854 mm., 61.3; anal 2385 mm., 78.9. *Interspace between:* 1st and 2nd dorsals 758 mm., 25.1; 2nd dorsal and caudal 290 mm., 9.6; anal and caudal 233 mm., 7.7. *Distance from origin to origin of:* pectoral and pelvics 927 mm., 30.7; pelvics and anal 494 mm., 16.3.

Although relatively lighter than the others, the weight of the specimen falls within the expected range of weights of the several sharpnose mackerel sharks listed by Bigelow and Schroeder (1948: 128) that ranged from six feet to ten feet, six inches in length and from 135 to 1009 pounds in weight.—LOUIS A. KRUMHOLZ, *Department of Biology, University of Louisville, Louisville, Kentucky.*

A REMARKABLE INSTANCE OF PARALLELISM AMONG TELEOST FISHES.—The phenomenon of parallelism (*vide* Haas and Simpson, 1946, Proc. Amer. Philos. Soc., 90 (5): 319–349) indicates relationships, that otherwise might be overlooked, between a particular kind of organism and its particular environment, as well as among structures belonging to each of the parallel forms. That two more or less phylogenetically unrelated organisms, living in similar environments, exhibit similar structures indicates a similarity of interaction between certain features of environment and organism, as well as among the functions of the various parallel structures in each organism. What these features are and the causal relationships between them may not be evident, but profitable lines of investigation to reveal hitherto unrecognized ecological and physiological data should be apparent.

Recent studies have shown that a number of fishes emit small, regularly fluctuating electric currents into the water surrounding them. The morphology and physiology of their electric organs are being described in increasing detail (*e.g.* by Couceiro *et al.*, 1955, Ann. Acad. Brasileira Ciênc., 27 (3): 323–328, de Oliveira Castro, 1955, *Ibid.*, 27 (4): 557–560, Ishiyama and Kuwabara, 1955, Jour. Shimonoseki Coll. Fish., 4 (2): 203–209, Kuwabara, 1957, *Ibid.*, 6 (2): 149–240, Kleerekoper and Sibakin, 1956, Jour. Fish. Res. Bd. Canada, 13 (3): 375–383, Szabo, 1956, C. R. Acad. Sci. Paris, 242 (16): 2045–2048, Grundfest, 1957, Progress in Biophysics and Biophysical Chemistry, 7: 1–85), but the significance of this faculty in the lives of the fishes, with the possibility that special sensory receptors exist to utilize the discharges, remains an enigma (Coates, 1954, Animal Kingdom, N. Y. Zool. Soc., 57 (6): 182–186). That two Families of electrogenic fishes, belonging to different Orders, exhibit other characteristics in

common may show the way to an elucidation of the ecological and functional significance of this unusual faculty.

In all, seven species of gymnotid eels, including the well known electric eel, *Electrophorus*, have been shown to be electrogenic, and no gymnotid tested has lacked this ability (Coates *et al.*, 1954, Science, 120 (3125): 845–846, Coates, 1955, Zoologica, N. Y., 40 (4): 197–198). With the assistance of Dr. Mario Altamirano, we have tested seven species of mormyrids belonging to the genera *Gnathonemus*, *Marcusenius*, *Mormyrus* and *Petrocephalus*; all of them proved electrogenic. Previously, mormyrids of the genera *Mormyrops* and *Mormyrus* had been found to produce small but regular electric discharges (Lissmann, 1951, Nature, 167 (4240): 201–202, Anon., 1952, Ann. Rpt. East African Fish. Res. Organ. for 1951: 4–5). It seems reasonable to assume that most or all of the members of these two Families are electrogenic. They also show parallelism in body form, way of swimming, and feeding habits and social behavior at least as indicated by the reactions of captive specimens. The heads of certain gymnotids approach in form the stout or elongated downward curved snouts which have given some of the mormyrids the name of elephant fish, while *Gymnarchus*, an electrogenic relative of the Mormyridae closely resembles a gymnotid except that the long, principal locomotor fin runs along the back instead of the belly. All the gymnotids and mormyrids known to us readily swim backwards and so does *Gymnarchus*, according to Lissmann (*loc. cit.*). We have found that fishes of both Families feed best on tubificid worms and that all of them are "nervous" and quarrelsome, usually requiring quarters separated from any other members of their own Family. Both groups inhabit tropical, freshwater lakes, streams and backwaters, but we do not know how alike are the ecological niches they occupy. Practically nothing is known about their reproductive habits.

We predict that a comparative study of the morphology, physiology, behavior and ecology of the Families Gymnotidae (plus Electrophoridae) and Mormyridae (plus Gymnarchidae) will go far in shedding light on the electrogenic properties of fishes.—James W. Atz and Christopher W. Coates, *New York Aquarium, New York Zoological Society, Brooklyn, New York.*

CICHLAURUS VERSUS *CICHLASOMA* AS THE NAME FOR A GENUS OF PERCIFORM FISHES.—The large (nearly 100 species) genus of cichlid fishes of Middle and South America known most often as *Cichlasoma* (spelled *Cichlosoma* by Regan, 1905, Ann. Mag. Nat. Hist., 7th ser., 16: 68) or as *Heros* Heckel, 1840, was divided by Jordan, Evermann, and Clark (1930, Rept. U. S. Comm. Fish., 1928, Pt. 2: 416–422) into several (seven if contrasted to Regan's arrangement) smaller genera. This is a characteristic action, for this work achieved the ultimate in splitting thus far experienced in North American ichthyology. A conspicuous feature, however, is the failure to use the name *Cichlasoma* for any one of the constituent groups. Instead these authors applied the equivalent name *Cichlaurus* which, like *Cichlasoma*, first appeared in Swainson (1839, Natural History and Classification of Fishes, Amphibians, and Reptiles. London: A Spottiswoode, 2).

Cichlaurus was proposed on page 173 in a list of generic names, with the simple characterization "Mouth oblique; caudal rounded." No species was mentioned. From this it would be impossible to interpret the author's meaning were it not for the fuller description given in the text under *Cichlasoma*, as was indicated by Swain (1883, Proc. Acad. Nat. Sci. Phila., 1882: 284). Swainson unaccountably substituted *Cichlasoma* (p. 230) for *Cichlaurus* (p. 173). As first reviser, Swain (1883, *op. cit.*, 272–284) selected *Cichlasoma* in preference to *Cichlaurus*. *Cichlaurus* was omitted from the index to Swainson's work, which perhaps accounts for its having been overlooked by most workers. Jordan (1919, Genera of Fishes. Stanford Univ. Pub., Univ. Ser., Pt. 2: 198) and Jordan, Evermann, and Clark (*op. cit.*) resurrected *Cichlaurus*, presumably because of page priority. Although followed in this treatment by Eigenmann and Allen (1942, Fishes of Western South America. Univ. Ky. Press: 395), most workers have continued to use *Cichlasoma*. Because of the temporary validation of the Principle of Page Precedence by the International Commission on Zoological Nomenclature (1950, Bull. Zool. Nomencl., 4: 330–331), however, Travassos (1953, *Dusenia*, 4: 19–26) indicated the need to substitute *Cichlaurus* for *Cichlasoma*. At the time his paper appeared, a request to the International Commission to preserve the familiar name *Cichlasoma* under the plenary powers was awaiting publication in the Bulletin of Zoological Nomenclature. The reinstatement by the Commission of the Principle of First Reviser (1953, Copenhagen Decisions Zool. Nomencl., 66–67) made it unnecessary to publish that request.

In view of the clear choice of *Cichlasoma* over *Cichlaurus* by Swain, the name in accustomed use, *Cichlasoma* Swainson, 1839, may be retained. The type species of *Cichlasoma*, by monotypy, is *Labrus punctata* Bloch, 1792, regarded by Regan (1905, *op. cit.*, 68) as a synonym of *Labrus bimaculatus* Linnaeus, 1758 (*Syst. Nat.*, 10: 285). The gender of *Cichlasoma* is neuter.

I am indebted to Dr. William A. Gosline, who

first directed my attention to Swain's paper.—REEVE M. BAILEY, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

FISHES OF THE FAMILY GEMPYLIDAE COLLECTED BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS 1929, 1930, 1931 AND 1934.—While studying the larval gempylids from the Florida Current under the National Geographic Society-University of Miami Pelagic Fish Life History Program, the opportunity arose to examine those gempylids collected by William Beebe during the Bermuda Oceanographic Expeditions 1929–31 and 1934. All of the specimens were taken within an eight-mile circle whose center is at 32°12'N. latitude and 64°36'W. longitude, nine and one-quarter miles south-southeast of Nonsuch Island, Bermuda.

The fishes are in the collections of the Natural History Museum, Stanford University, SU Nos. 45052–45162. Of the 159 specimens, 129 were definitely identified and the remaining 30 were, for the most part, too damaged to make determination possible. The collection contained postlarvae of *Nealotus tripes* Johnson, *Nesiarchus nasutus* Johnson and two distinct larval forms of *Gempylus* Cuvier and Valenciennes.

Complete net data are contained in *Zoologica* (1931, 13 (2): 16–36; 1932, 13 (3): 37–45; 1936, 21 (1): 69–73). A few specimens could not be assigned to a definite net because some catches had been combined; others lacked data completely. The numbers given in parentheses are the standard lengths in millimeters of the specimens.

I wish to thank Dr. George S. Myers of Stanford University for the loan of this material.

Nealotus tripes Johnson. Five specimens: (5.2, 9.8) net Nos. 921, 923; (21.0) net 462; (24.0) net 388; (34.0) net 308. Captured during the months of July through September at depths ranging from 914 to 1646 meters. The 5.2 mm. larva is the smallest recorded specimen of this species.

Nesiarchus nasutus Johnson. Twenty specimens: (4.5, 14.2) net No. 1306; (4.8) net 919; (5.6, 17.6) no data; (5.9) net 464; (6.9) net 401; (7.7) no data; (8.7, 9.8) net 414; (9.6) net 1286; (9.9) net 490; (10.5) net 1202; (10.9) no data; (12.0) no data; (12.5) no data; (14.3) no data; (14.7) net 436; (22.0) net 1301; (24.0) net 329. Captured during the months of July through September at depths from 7 to 2011 meters. Of the 13 larvae with data, five, from 4.5 to 22.0 mm. in size, were taken in the upper 100 meters; one, 12.5 mm., at 549 meters and seven, from 4.8 to 24.0 mm. in size, from 1280 to 2011 meters. The 4.5 mm. specimen is the smallest of this species yet recorded.

Gempylus Cuvier and Valenciennes. In a former paper (Voss, 1954, Bull. Mar. Sci. Gulf and Caribbean, 4(2): 120–159), I described and illustrated series of two distinct larval forms belonging to this generally considered monotypic genus, referring to them as *Gempylus* A and *Gempylus* B. This collection also contained both forms.

Gempylus A. Ninety-two specimens: (3.8, 5.5) net No. 361; (3.8, 8.3) net 1507; (4.1) net 722; (4.2) net 826; (4.4) net 545; (4.5) net 871; (4.8, 13.4, 15.3) no data; (5.0, 6.5) net 808; (5.1, 9.0, 10.5) nets 398, 399; (5.3) net 1199; (5.3, 13.2, 18.3) no data; (5.6) net 740; (5.7, 11.6) no data; (6.0) no data; (6.0) net 729; (6.3) net 1069; (6.3) net 387; (6.3) net 228; (6.3, 6.5) nets 1055, 1056; (6.3) no data; (6.3) net 748; (6.5) net 746; (6.5) net 801; (6.6) net 724; (6.8) net 750; (6.8) net 1506; (6.8, 12.6) net 695; (7.1) net 774; (7.2) net 44; (7.5) net 480; (7.5) net 699; (7.5) net 1252; (7.5) no data; (7.5, 11.0) net 1046; (8.1) net 682; (8.1) net 847; (8.3) net 1183; (8.3) net 876; (8.3) net 930; (8.3) net 732; (8.3) net 458; (8.4) net 1183; (8.4) net 1185; (8.4, 17.3) net 963; (8.7) net 877; (9.0) net 1184; (9.0) net 660; (9.0) net 425; (9.3) net 1177; (9.3) net 1222; (9.3) net 875; (9.5) net 1190; (9.6) net 786; (9.8) net 751; (9.8) net 273; (9.9) net 1504; (10.5) net 624; (10.5) net 449; (10.8) net 777; (11.0) net 857; (11.3) net 186; (12.0) net 717; (12.0, 21.5, 33.0) no data; (12.8) net 834; (12.8) net 1332; (12.8) net 574; (13.1) net 308; (13.2) net 809; (13.5) net 469; (15.8) net 367; (19.5) net 1198; (22.0) net 319; (25.0) net 192; (27.0) net 238; (33.0) net 321; (identifiable fragment) no data. Captured during the months of April through October at depths from 92 to 1829 meters. Of the 77 larvae with data, eight, from 3.8 to 11.0 mm. in size, were taken in the upper 500 meters; ten, 3.8 to 27.0 mm. in size, from 500 to 1000 meters, and 59, 4.1 to 33.0 mm. in size, from 1000 to 2000 meters.

Gempylus B. Twelve specimens: (8 specimens, 4.5–8.1) net No. 920; (6.5) net 1238; (8.0) net 826; (9.3) net 490; (14.4) net 1295. Captured during the months of June through August at depths from 0 to 1829 meters. Of the 12 larvae, nine, from 4.5 to 9.3 mm. in size, were taken in the upper 100 meters and three, from 6.5 to 14.4 mm. in size, from 1000 to 2000 meters.

Adults of *Nealotus*, *Nesiarchus* and *Gempylus* are all known from Bermuda. In my earlier work with gempylids from the Florida Current (*op. cit*), the larvae of *Nesiarchus* and *Gempylus* A were found over a depth range of 0 to 347 meters. The bottom depth was seldom more than 740 meters in the collecting area and was usually much less. Off Bermuda, where the herein reported larvae were collected, the bottom depth was never less than 1829 meters and extended to about 2743 meters. The vertical range of the larvae of *Nesiarchus* and *Gempylus* A in these waters increased with the greater water depth; they were found from the sur-

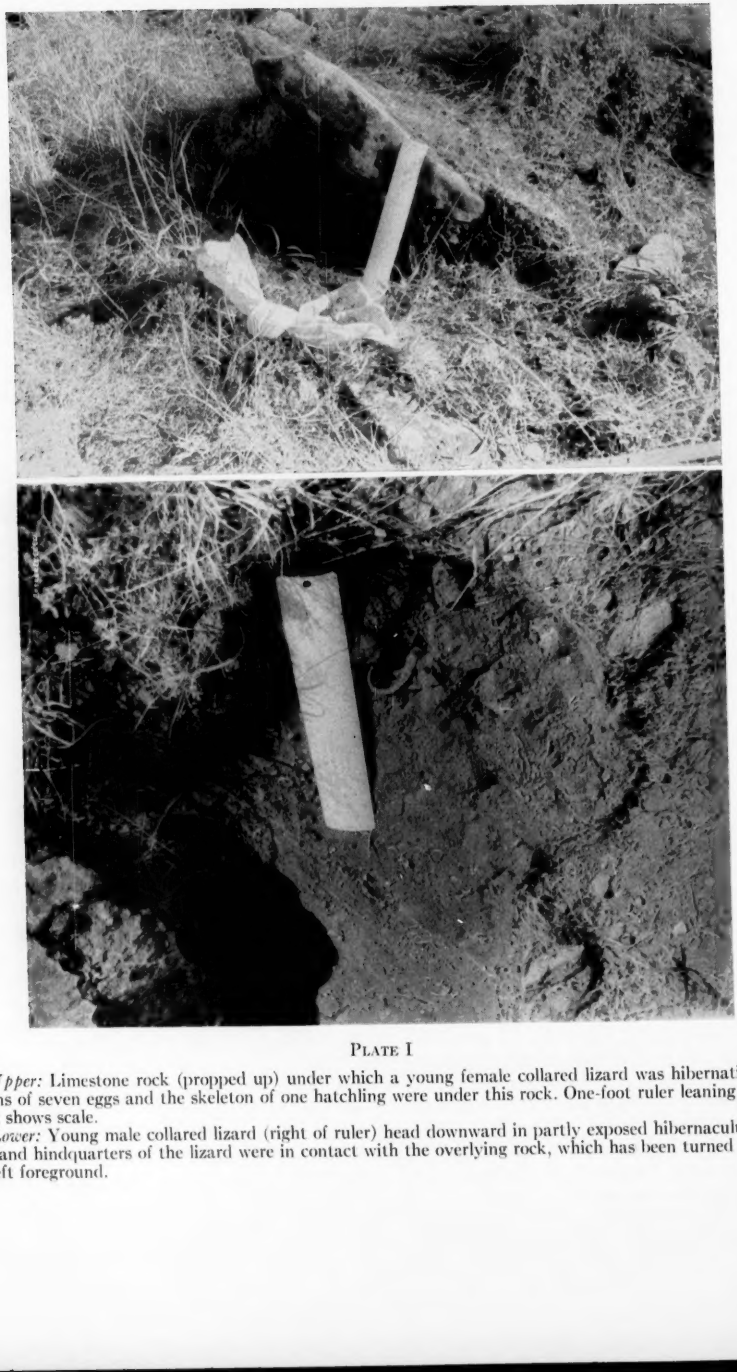


PLATE I

Upper: Limestone rock (propped up) under which a young female collared lizard was hibernating. Remains of seven eggs and the skeleton of one hatchling were under this rock. One-foot ruler leaning against rock shows scale.

Lower: Young male collared lizard (right of ruler) head downward in partly exposed hibernaculum. The tail and hindquarters of the lizard were in contact with the overlying rock, which has been turned and lies in left foreground.

face to 2011 meters. Since larvae of three and four millimeter size were found at both extremes of depth, it is apparent that the adults of these two species spawn throughout their vertical range and not just in the surface waters as I had previously supposed. This may also be concluded for *Gempylus* B. Its larvae formerly had only been taken in the upper 70 meters; the Bermuda specimens extend the range down to 1829 meters. Not enough larvae of *Nealotus* have been collected to give a picture of the vertical range of its young.

The collecting dates cannot be used to define definite spawning periods, for work was not carried out on a year around basis. The depths given are those of intended fishing since the nets were not of the closing type. There is always the possibility, of course, that a few of the specimens were caught at shallower depths while the net was being raised. The small number of larvae found in the surface waters may be partly accounted for by the fact that the majority of the hauls were made below 900 meters.—NANCY A. VOSS, CONTRIBUTION NO. 183, *The Marine Laboratory, University of Miami, Coral Gables, Florida.*

Herpetological Notes

OBSERVATIONS ON HIBERNATION AND NESTS OF THE COLLARED LIZARD, *CROTAPHYTUS COLLARIS.*—Collared lizards hibernating under natural conditions were studied in the winter of 1955–56 near Welda, Anderson County, east-central Kansas, in an area of rolling bluestem prairie having abundant loose flat rocks and limestone outcrops. Visits were made to this area on November 25 and December 30, 1955, and March 13, 1956. At these times, the air temperatures ranged from 4°–7° C. Temperatures of the lizards, and of the soil and air nearby, were obtained with a Schultheis quick-reading thermometer. On each trip we were accompanied and helped by Mr. Wm. R. Brecheisen of Welda.

The few published observations on reptiles hibernating under natural conditions are mostly based on accidental discoveries. It is therefore noteworthy that we found hibernating collared lizards on each of our visits. The study area is in a region where winter temperatures often fall below zero Fahrenheit, and where the collared lizard and other reptiles regularly spend more than half the year in dormancy. The habitat was exceptionally favorable for collared lizards because of the abundance of large rocks. We found no other hibernating reptiles.

Of the 11 hibernacula examined, most were on a gentle northeast-facing slope, but a few were on nearly level ground. All were beneath more or less flat limestone rocks, which typically were well embedded in the soil on their uphill sides, but had their downhill sides either flush with the surface of the soil or slightly elevated, rendering them available as shelter for various small animals. The rocks used as shelter varied in size and shape, but were mostly two to three feet in greatest diameter (average of eight, 30.6 inches), and one inch to ten inches thick (average of eleven, 3.9 inches). The adult collared lizards were generally under more massive rocks than were the juveniles. Rocks of a diameter much smaller than the average mentioned above, or those rocks that were not flat, or that offered no free edge beneath which a lizard could burrow, seemingly were unsuitable for hibernation sites. Many potential sites for hibernacula, under rocks too large to be turned by the combined efforts of three men, or under outcroppings of bedrock, were inaccessible to us.

A typical hibernaculum (Pl. I) consisted of a chamber barely large enough to accommodate the lizard, dug into earth beneath the deepest part of the rock. The rock usually formed the roof of the chamber, but often the chamber was in the soil a few inches beyond the buried edge of the rock. A tunnel, filled with earth for at least part of its length, led from the free edge of the rock to the hibernaculum. Our attention was sometimes attracted to such a tunnel by loose earth at its mouth beneath the rock. The total depth of cover over a hibernaculum averaged approximately eight inches, and in only one instance exceeded a foot (13½ inches). For four adults, depths averaged 11.4 inches, while for seven juveniles depths averaged 6.6 inches. The adults normally become inactive in early autumn, several weeks before the young, when temperatures in the burrows are much below air temperatures; the adults probably spend more time than the young in excavating burrows. Depths of some burrows were limited by an underlying layer of limestone, and in two such burrows the bodies of the lizards were in broad contact with rock, above and below. The shallowest hibernaculum was of this type, and was roofed by a scant 1½ inches of rock.

Seven of 11 hibernacula each contained a single adult or juvenile, but each of two hibernacula was shared by two half-grown females. Brecheisen told

us that he had found two hibernacula under a rock approximately four feet in diameter, one containing an adult female, and the other containing four immature lizards of undetermined sex; under another rock of similar size he found a hibernaculum containing an adult female and two immature lizards.

As soon as possible after unearthing the lizards we recorded their body temperatures, handling them with heavy gloves. Probably both the temperatures of the lizards and those of the soil where they lay changed slightly before we were able to record them. Average temperatures (in degrees Centigrade) of lizards and of nearby soil in hibernacula were, respectively, on November 25, 6.9 and 6.9; December 30, 3.3 and 3.6; and on March 13, 5.5 and 8.3.

The body temperatures at which purposeful movement is possible for collared lizards (somewhat above 15° C., Fitch, Univ. Kansas. Publ., Mus. Nat. Hist., 8 (7): 443) seemingly allow little possibility of movement from one hibernaculum to another once hibernation is begun in autumn. Two lizards in a hibernaculum, positively marked by Brecheisen on October 17, could not be found there on November 25, despite thorough search. It seems more likely that they had been found by predators than that they had moved voluntarily. Definite signs of predation were lacking, but the hibernaculum and tunnel were no longer discernible in the loose earth under the rock. Brecheisen observed badger diggings under most of the flat rocks in a nearby pasture.

Lizards found in hibernacula were dormant. They were lying in a characteristic posture, usually facing outward, with the head depressed, eyes shut, the torso slightly bent laterally, the limbs gathered in close to the body, and the tail curled in a spiral. They were immobile until removed and handled. The color of the skin was dull brown, with the pattern less distinct than in active individuals at higher temperatures. When aroused and stimulated they were capable of slow, poorly coordinated movements of the limbs and serpentine movements of the trunk and tail. When prodded they would open the mouth and hiss, and would bite if an opportunity presented itself. One lizard, when placed on a rock in the open, rose as high as possible by straightening and stiffening his forelegs. Some of the lizards that were aroused and handled voided clear watery liquid. In this they differed from active collared lizards, which, when caught and handled, may defecate and may void excreta, from the kidneys, in more or less solid masses or of the consistency of thick enamel paint.

Some mortality in the course of hibernation must be normal. Several of the hibernacula we found were so close to the surface that the occupants seemed to be in grave danger of freezing. The lethal minimum for the species is not known, but probably is near freezing. However, on all three dates of observation, each lizard exposed for the first time in its hibernaculum was alive and seemingly in good condition. But so far as known, none of the lizards that we exposed survived the winter, despite our painstaking efforts to restore the cavities and the entrance burrows to simulations of their original conditions, and to return the sheltering rocks to their former positions. Two juvenal females in one hibernaculum and an adult in another, found on November 25, were still alive and seemingly in good condition on December 30, but all were dead on March 13. It seems that microclimates of the hibernacula were altered in ways that were harmful to the lizards. In each instance, the rock, too heavy to be raised completely, was moved by tilting up the free edge. This resulted in compacting of the soil about the hibernaculum. When lowered into place, such a rock no longer fitted perfectly into the mold of soil beneath it. Although we were careful to fill any remaining crevices with loose soil, insulation may have been impaired to the extent that the hibernating lizards were exposed to freezing. The lowest and second lowest body temperatures recorded by us were 2.6° and 3.2°C., respectively, taken from two immature females that were together in a hibernaculum seven inches deep on December 30.

Probably our disturbance of hibernation sites was the cause of subsequent mortality, even in two recorded instances of predation. On December 30, eleven or more deer mice (*Peromyscus maniculatus bairdii*) of adult or nearly adult size, ran from a nest beneath the rock where a young female lizard had been hibernating on November 25. The mouse nest, of grass, duck feathers, and hair, had been built in the somewhat enlarged cavity of the original hibernaculum. Pieces of the lizard's skin were found beside the nest. An adult male lizard also discovered on November 25 was dead in his foot-deep hibernaculum at the end of a tunnel on December 30. Skin and flesh had been eaten from his head, neck, trunk, and tail. Either the deer mouse or the little short-tailed shrew (*Cryptotis parva*) probably was responsible. It is, of course, uncertain whether these lizards were still alive at the time they were attacked.

In our search for hibernacula we discovered several old nests of collared lizards beneath rocks. The majority of these nests contained only the collapsed shells of hatched eggs. However, in three nests, skeletons of hatchlings which had been unable to escape, were associated with eggshells. In one instance the remains of hatchlings were found at the end of an eight-inch tunnel that led from the nest cavity farther back beneath the buried portion of the rock rather than toward its free edge. The eggs in two other nests contained the skeletons of nearly full-term embryos. Reasons for the young failing to escape from the burrows are not definitely known, except in the one instance of those that dug in the

wrong direction. Exceptionally hot weather might have caused mortality, as the nests were all near the surface; or dry weather may have caused hardening of the soil so that the hatchlings were unable to break through to the surface. In any case, it seems that frequently entire broods of hatchlings die without escaping from the nest chamber.

In several instances a hibernaculum and an old nest were found beneath the same rock, suggesting that the general physical requirements for hibernating and nesting sites are somewhat the same in this area. However, in general, hibernacula were deeper and better protected than were nest cavities. —JOHN M. LEGLER AND HENRY S. FITCH, *University of Kansas, Lawrence, Kansas.*

THE LAMINAL SPURS OF THE JUVENILE GOPHER TORTOISE, *GOPHERUS POLYPHEMUS* (DAUDIN).—The gopher tortoise, *Gopherus polyphemus* (Daudin), is common in the Southeastern United States, but its biology is not well known. The brightly colored young were recently described (Allen and Neill, 1953, COPEIA (2): 128).

Certain morphological features of the juvenile gopher tortoise remain to be discussed. One of these is a structure we term a laminal spur—a hard, sharp outgrowth from the posterolateral margin of each humeral lamina. This spur is directed posterolaterally and inferiorly (Fig. 1).

The specimen figured was collected on May 13, 1957, at Silver Springs, Marion County, Florida. When taken it was 58 mm. in plastron length, and was probably 8 or 9 months old. Tortoises more than 100 mm. in plastron length never exhibit the spurs.

In the hatchling gopher tortoise, there are also two tiny points on the anterior edge of each gular lamina; a similar one at the tip of each anal lamina; and an even more minute one on the lateral margin of each femoral lamina. These extremely small, sharp projections are probably homologous with the much larger spurs of the humeral laminae. On the carapace of the hatchling, the free edge of marginals 1, 2, 3, 8, 9, 10 and 11 is hyaline and sharp; marginals 4 through 7 are ridged; the anterior edge of the precentral bears several very minute spinosities; and there are two or three pairs of tiny spines on the posterior edge of the postcentral. In short, every free edge of an epidermal lamina tends to be sharp or spinose; but very close examination is necessary to reveal this, and only the humeral lamina bears a really conspicuous spur.

Laminal spurs have not been reported in any species of *Gopherus*. Miller (1932, Trans. San Diego Soc. Nat. Hist., 7 (18): 194) remarked of the desert tortoise, *G. agassizi*, "The nuchal and the caudal plates are both incomplete at birth, both of them being deeply notched and crenulated on the free

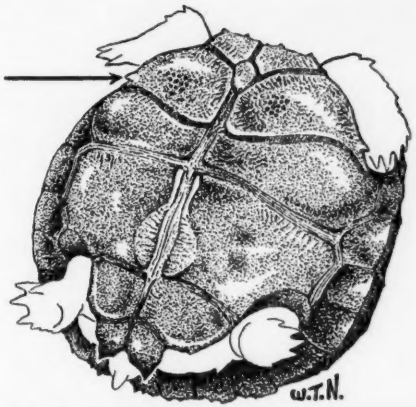


Fig. 1. Juvenile *Gopherus polyphemus*, plastral view; details of soft parts omitted. Arrow indicates a laminal spur.

margin as though they were growing out by granulation. All other scutes including marginals are shaped approximately as in the adult." Hatchlings of the Texas tortoise, *G. berlandieri*, seemingly have not been described in detail. Carr (1952, Handbook of Turtles: Pl. 4) figured a young example of this species; the precentral, postcentral and certain marginals appear to be somewhat crenulated, much as in the specimens of *G. agassizi* figured by Miller (*op. cit.*; 1955, COPEIA, (2): 113–118).

Figure 1 illustrates other peculiarities of the juvenile *Gopherus polyphemus*. There is an intergular lamina, a feature not evident in adults. The umbilical area is covered by a wrinkled, plate-like structure which is distinct from the abdominal laminae. The plate is split longitudinally by the midplastral seam. As the tortoise grows, this seam widens, pushing the two halves of the plate farther apart. In a tortoise with a plastron length of 125 mm., the halves of the plate were separated by 35 mm. In small examples the gulars do not protrude.—WILFRED T. NEILL AND E. ROSS ALLEN, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

THE SOUTHERN PAINTED TURTLE IN OKLAHOMA.—Both Carr (Handbook of Turtles, 1952) and Schmidt (Checklist of North American Amphibians and Reptiles 6, 1953) do not include Oklahoma within the range of *Chrysemys picta dorsalis* Agassiz; but both indicate a northward extension of its range in the Mississippi Valley.

On April 6, 1957, we collected a turtle in a woodroad beside Little River near the U. S. Highway 70 bridge about 3 miles northeast of Idabel, McCurtain County, Oklahoma. The specimen (No. 28663, Stovall Museum, University of Oklahoma) measured

90 mm. straight-line carapace length and 84 mm. in greatest carapace width. The dorsal stripe was brick red and complete.

On April 18 or 19, 1957, Dr. Virgil Dowell and Mr. Wm. E. Vinyard took another specimen from a small stream 2 miles east and ½ mile south of Harris, McCurtain County, Oklahoma. This is in the only region where palmetto grows in Oklahoma and other southern elements of both flora and fauna occur.

The first specimen mentioned came from the region between the two largest settlements (Idabel and Broken Bow) in this sparsely settled country but the second was collected several miles from any except quite small settlements. Accordingly we believe these specimens to represent a true population of this turtle. Presumably, the Red River Valley has served as a highway and the turtle has also migrated up tributaries from this. If this be the case, one may expect eventually to find these turtles in appropriate habitats in southwestern Arkansas, northeastern Texas, and adjacent Louisiana.—ARTHUR N. BRAGG AND WILLIAM N. BRAGG, *Biological Survey, University of Oklahoma, Norman, Oklahoma.*

PLETHODON CINEREUS DORSALIS IN MISSISSIPPI.—The southern range of this salamander is northern Alabama and NW Georgia (Bishop. Handbook of Salamanders, 1947; Neil, COPEIA 1957 (1): 43–47). There is no published record of this subspecies in Mississippi. On March 15, 1952, the writer and C. B. Segars collected fifteen *P. c. dorsalis* from Tishomingo State Park in Tishomingo County, Mississippi. This extends the known distribution to south of the Tennessee River. The divide between the Tennessee drainage and Tombigbee River runs through this park; *dorsalis* was found up to this divide, but not on the Tombigbee side. The animals were quite common under slabs of sandstone on the slopes draining to Bear Creek. This paleozoic sandstone is part of the only outcrop of this age in the state. At least 50 specimens were seen on the first trip. Five specimens were deposited in the collection of Mississippi Southern College in Hattiesburg. The writer has made eight other trip to the area, the last being April 22–24, 1957. Specimens were seen each time.—WILLIAM E. BRODE. *Gulf Coast Research Laboratory, Ocean Springs, Mississippi.*

AMPHIBIANS AND REPTILES OF GLACIER NATIONAL PARK, MONTANA.—The area of Flathead and Glacier Counties in the Rocky Mountains of northwestern Montana, comprising Glacier National Park, is not noted for the variety of its herpetofauna. Ten species are represented by specimens collected within the Park.

Glacier National Park, a region of 1500 square miles, adjoins the southern boundary of Alberta and straddles the Continental Divide. Elevations range from 3,050 feet along the western boundary to 10,438 feet above sea level at the summit of Mount Cleveland. Tongues of Transition Zone extend into the Park along the eastern and western edges. But the area is primarily within the heavily forested Canadian Zone, capped above with tracts of Hudsonian and Alpine communities. Timber line ranges between 7000 and 8000 feet elevation. There are some 200 lakes and countless rivers and streams in the Park. The climate is a limiting factor for most poikilothermal forms. Snow may be expected in any month of the year. The climate at the lower levels may be typified by the following figures, compiled over 30 years by the U. S. Weather Bureau near Babb, at the eastern edge of the Park (4500 feet): average January temperature, 17.7°; average July temperature, 60.1°; maximum, 96°; minimum, −53°F.; average growing season, 102 days, May 29 to September 8; average annual precipitation, 19.43 inches.

The writer spent the summers of 1954 and 1955 as a naturalist stationed at the Many Glacier Ranger Station on the eastern side of the Park. Specimens in the Park collections, as well as observations on widespread exploratory trips, are the principal basis for this list. Included are a few species known from adjacent country and to be expected along the margins of the Park, though not yet so recorded. My nomenclature follows that of Stebbins (Amphibians and Reptiles of Western North America, 1954).

Ambystoma macrodactylum Baird. The long-toed salamander occurs at lower levels on both sides of the Divide. There are records from Park Headquarters (3154 feet) to Lake Evangeline (4800 feet), as well as from St. Mary and John's Lakes.

Ambystoma tigrinum melanostictum (Baird). One adult specimen of the blotched tiger salamander was collected about 4 mi. NE Marias Pass Summit (5000 feet). Larvae in the U. S. National Museum were collected at Camas Lake (4600 feet).

Ascaphus truei montanus Mittleman and Myers. The Rocky Mountain tailed frog is not often taken, but specimens are recorded from Lake McDonald (3144 feet) to Lake Evangeline (4800 feet), as well as from Coal, Dutch, Ole and Park Creeks, all west of the Divide.

Scaphiopus sp. There are no Park records of spadefoot toads, but the area is close to the range of *bombifrons* on the east and *hammondi* on the west.

Bufo boreas boreas Baird and Girard. The western toad is widely distributed throughout the area, from the Sprague Creek campground (3150 feet) to the Brown Mountain fire lookout (7041 feet) and the vicinity of the Granite Park Chalets (6400 feet), as well as from the vicinity of Cracker, Josephine, Red

Eagle, St. Mary, Swiftcurrent and Waterton Lakes, and Camas and Roes Creeks.

Hyla arenicolor Cope. In the U. S. National Museum is one specimen from Fish Creek (ca. 4200 feet) identified as the canyon tree frog, usually occurring far to the south.

Hyla regilla Baird and Girard. The Pacific tree frog is regarded as common throughout the area, but the Park collection contains only one specimen from the junction of the Middle and North Forks of the Flathead River (3050 feet) on the western boundary.

Rana clamitans Latreille. In the Chicago Natural History Museum is one specimen of the green frog from Bowman Lake (4020 feet) on the western side of the Park. It may have been introduced there by fishermen from the east.

Rana pipiens brachycephala Cope. The area is well within the range of the western leopard frog, but no specimens have yet been recorded from the Park.

Rana pretiosa pretiosa Baird and Girard. The western spotted frog is common throughout the Park from West Glacier (3219 feet) to Beaver Woman Lake (5885 feet) on the western side and from St. Mary Lake (4473 feet) to Josephine Lake (4900 feet) on the east. It is recorded also from Waterton, Red Eagle and Howe Lakes, Lincoln, Camas and Roes Creeks, and elsewhere.

Chrysemys picta belli (Gray). The western painted turtle has not been recorded from the Park, but should be looked for in the lower waters.

Charina bottae utahensis Van Denburgh. There are no Park records for the Rocky Mountain rubber boa, but it may be expected on either side of the Divide.

Thamnophis elegans vagrans (Baird and Girard). The wandering garter snake is the large race of the mountainous areas and the common form throughout the Park. It occurs on both sides of the Divide, and from the level of Park Headquarters (3154 feet) to about 6000 feet, as on the trail to the Sperry Chalets and on the eastern slopes of Grinnell Point. Other records are from the vicinity of Lincoln, St. Mary, Red Eagle, Swiftcurrent and Josephine Lakes, Mount Altyn and the Many Glacier Ranger Station.

Thamnophis sirtalis parietalis (Say). The red-sided garter snake occurs at the lower levels, as at Lake McDonald (3150 feet) and Lake Sherburne (4774 feet), and has been recorded at Fish, Howe and John's Lakes and the vicinity of Belton. Stebbins (*op. cit.*, 506) suggests that "the subspecies *fitchi* may range as far east as Glacier National Park in Montana."

Coluber constrictor Linnaeus. The racer has not been recorded from the Park, but the area is in the zone of intergradation between the eastern race *flaviventris* and the race *mormon* to the west, both of which may occur in the lower valleys.

Pituophis catenifer sayi (Schlegel). There are no Park records for the bull snake, but this Great Plains form may well occur along the eastern boundary.—Richard H. Manville, *151 Ossining Road, Pleasantville, New York.*

ADDITIONAL SPECIMENS OF *TRIMORPHODON VILKINSONI* FROM TEXAS.—While engaged by the Department of Wildlife Management in an ecological survey of the Big Bend area, the senior author found a specimen of *Trimorphodon vilkinsoni* Cope on June 20, 1956, at 9:30 PM near Grapevine Spring, elevation, 3040 feet. The snake was found crawling on the bare ground near an inhabited adobe house. The air temperature was 87°F., the sky was cloudy, and a stiff breeze was blowing. The snake, preserved February 5, 1957, will be deposited in the Texas Cooperative Wildlife Collection at the A. and M. College of Texas.

On July 11, 1956, at about 9.00 PM, another individual was taken by the junior author in the Chisos Basin (5400 feet elevation) in the Big Bend National Park. It was lying on the edge of a black-topped road. This individual was kept alive until January 9, 1957. It will be deposited in the Natural History Collection of the Big Bend National Park.

Both specimens are males. Measurements and scale counts are, respectively: Total length 760 mm., 476 mm.; tail 144 mm., 83 mm.; scale rows 21-23-15, 21-22-15; ventrals 230, 228; subcaudals 84, 81; supralabials 9-9, 9-8; infralabials 12-12, 11-12; preoculars 3; temporals 3-4-4, 3-3-4; loreals 3-3, 2-2; anal divided. The coloration is similar to previously published descriptions of this form. Body bands number 24 and 19; tail bands, 14 and 10. With the exception of the greater number of crossbands, the larger specimen looks very much like the only published photograph of this form (Taylor, 1938, Univ. Kans. Sci. Bull., 25: 383).

Although various species of rodents, bats, birds, snakes, lizards, and frogs were offered as food during the time the snakes were kept alive, only lizards were taken. At first only dead lizards were accepted and for more than two months live lizards put into the cage were unmolested. Later, live lizards were taken when left in overnight; and, finally, the smaller snake accepted lizards from the hand during daylight hours. No preference was shown for any particular species of lizard and various species of *Cnemidophorus* and *Sceloporus*, as well as *Anolis c. carolinensis*, were taken. Details of habits and feeding were similar to those described for other members of the genus.

These are the fifth and six published locality records of this apparently rare form. Since the description of *T. vilkinsoni* by Cope in 1886, based on one specimen from "near the city of Chihuahua, Mexico", the literature records two examples of this form from the vicinity of El Paso, Texas, and

another from the Sierra Vieja in Trans-Pecos, Texas. The species is an addition to the known herpetofauna of the Big Bend National Park.—WILLIAM G. DEGENHARDT AND G. EARL STEELE, *Department of Biology, A. & M. College of Texas, College Station, Texas and Big Bend National Park, Texas.*

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES AS OF JANUARY 1, 1957.—In the list below only the maximum record for each species or subspecies is given. The age of each snake is given in years (second column) and months (third column), with the source of the record in the fourth column. An asterisk indicates that the snake was alive on January 1, 1957. This list includes only individuals still alive or those that died during the previous year. Snakes noted as having died during the preceding year will not be included in subsequent lists. Those interested in the most recent complete list of snakes living ten years or more in collections in the United States are referred to Perkins (1955, Copeia (3): 262). This list will be brought up to date as of the first of January each year. We would appreciate hearing from anyone having longer records, or ten-year records for other species. Symbols used are as follows: BdZ = Brookfield Zoo, GPM = George P. Meade, HPLMus = Holyoke Public Library Museum, JGM = John G. Moore, PZ = Philadelphia Zoo, SDZ = San Diego Zoo.

*Agkistrodon contortrix laticinctus**	16	7	SDZ
Boa constrictor imperator	18	10	SDZ
Crotalus atrox	20	4	SDZ
Crotalus horridus horridus	18	8	HPLMus
*Crotalus horridus atricaudatus**	10	3	SDZ
Crotalus ruber ruber	14	6	SDZ
Crotalus viridis helleri	19	5	SDZ
*Crotalus viridis viridis**	18	1	SDZ
*Drymarchon corais couperi**	24	4	JGM
*Epicrates angulifer**	18	2	SDZ
*Lampropeltis doliata amaura**	20	7	GPM
Lampropeltis doliata annulata	15	9	SDZ
*Lampropeltis doliata triangulum**	11	9	PZ
*Lampropeltis getulus holbrooki**	13	8	SDZ
*Loxocemus bicolor**	14	0	PZ
*Naja melanoleuca**	28	3	SDZ
Naja nigricollis	22	1	BdZ
Pituophis catenifer annectens (albino)*	16	7	SDZ
*Pituophis catenifer annectens**	15	7	SDZ
*Pituophis melanoleucus melanoleucus**	16	5	SDZ
*Pituophis melanoleucus mugitus**	10	11	BdZ
*Python curtus curtus**	20	10	SDZ
*Python molurus bivittatus**	20	9	SDZ
*Python regius**	11	9	PZ
Python sebae	19	11	PZ
*Rhinocheilus lecontei lecontei**	15	1	SDZ

CHARLES E. SHAW, *Zoological Society of San Diego, P. O. Box 551, San Diego 12, California.*

THYROIDLESS TADPOLES OF *PELOBATES SYRIACUS* BOETTGER H.—On May 29, 1956 four exceptionally large tadpoles of *Pelobates syriacus* were caught near Tel-Aviv (Grid. Ref.: 1240/1593) in a pool known as a spawning site of the syrian spadefoot toad. Considerable amounts of late rain had caused the shallow ditch to have water at a time when in most years no trace of it would have remained. The temperature of the pond at 3 PM was 30°C. Three of the tadpoles did not have rudiments of limbs but the fourth had all its limbs well developed and its body was short and compact.

At this locality Dr. H. Mendelsohn of the Biologic-Pedagogic Institute, Tel-Aviv, between May 8 and June 3, 1956, caught 26 giant tadpoles of *P. syriacus*. On October 10, 1956 ten were alive and in excellent condition. One specimen only showed very small hind-limbs. After this date only a few normal tadpoles were found; the bulk of the population had left the pond after completion of metamorphosis.

Giant tadpoles of *Pelobates fuscus* were recorded with a total body length of 150–170 mm. as compared with 100–120 mm. in typical tadpoles of the same species. Pfluger, (in Werner, 1922, Brehms Tierleben, 4) found that these tadpoles, like *Rana catesbeiana* and *R. clamitans* (Ingram, 1929, J. Exp. Zool., 53: 387–410) may spend the winter in the mud on the bottom of their natural lake habitat and survive through the next season, whereas tadpoles of *P. syriacus* in Israel pass their entire development and complete metamorphosis within one winter-spring period.

Since in the literature no mention had been made of the reason for the extraordinary growth of the *P. fuscus* tadpoles, I decided to investigate the condition of the thyroid gland. The thyroid of tadpoles of normal *P. syriacus* shows, as metamorphosis sets in, grossly and microscopically all the signs typical of this event. In the giant tadpoles, however, no thyroid gland was found when looked for under the dissecting microscope. Subsequently, from two such tadpoles the whole region normally containing the thyroid gland, plus an ample safety margin was sectioned to be sure of the absence of the gland and/or accessory follicles.

In these sections the nervus hypoglossus, normally passing through the thyroid gland of *P. syriacus*, could be followed easily, but nothing could be seen of thyroid tissue or any tissue indicative of a degenerated thyroid gland. With this evidence in hand it became imperative to study the condition of the giant tadpole which had advanced appreciably in its metamorphosis. Serial sections proved that in this individual, too, the thyroid gland was missing. This at once raised the question how metamorphosis could have started and proceed to the degree indicated above. No good explanation can be offered at this stage.

It is impossible to decide whether the thyroid had absolutely failed to develop in our giant tad-

poles or whether the gland, developing first, had degenerated. Notwithstanding the fact that no vertebrates lacking a thyroid gland are known, we have to assume the possibility of a failure of the thyroid to differentiate from the outset. Such a possibility is suggested by the absence of degenerative and/or scar tissue. Moreover, successful experiments are known where the removal of the thyroid anlage did not interfere with the growth of the tadpoles to even an excessive size (*Rana pipiens*—Allen, 1918, Jour. Exp. Zool., 24: 499–519). Further study of younger tadpoles of the giant type, if available, may help to answer this question.

The hypophysis of the giant *P. syriacus* was found to have a diameter twice that of the typical tadpoles. This means a disproportionate increase in its size, as the brain of the giants has not increased in proportion to their total size.

The study of the ultimobranchial body was made as part of a current investigation of this organ in the anuran amphibians of Israel. The ultimobranchial body of the giants has larger follicles than are usually present. Also, contrary to the normal, numerous clusters of lymphoid tissue are to be seen. Lymphoid tissue constitutes a normal part of the Ventraler Kiemenrest, but it seems that with regard to these giant tadpoles its part in this structure is considerably increased. Other concentrations of lymphoid tissue are mostly associated with the large numbers of trematode-cysts found in the giant tadpoles only. Normal *P. syriacus* tadpoles from other localities were never found infected with trematode-cysts.

Another peculiarity is revealed in the epithelium of the floor of the pharynx, of the larynx and of the gill-region that is much lower than usual. It is simple squamous around the capillaries of the gills, and irregular squamous to columnar in the larynx. The normally high columnar cells of the pharynx are in the large tadpoles lower with interspersed complexes of irregularly arranged cells.

Data are presented (Table 1) to facilitate comparison between normal and giant tadpoles of *P. syriacus*.

It is planned to investigate the other endocrine glands known to be influenced by the thyroid. Furthermore, those organs and tissues will be studied which undergo major structural changes during metamorphosis and in connection with the increased activity of the thyroid gland characteristic of this process.

Thanks are due to Dr. H. Mendelsohn of the Biologic-Pedagogic Institute, Tel-Aviv, for the information concerning the giant tadpoles caught by him and to Mr. E. Tur-Kochba of the same Institute, for having taken their weight and size measurements. I am grateful to Prof. G. Witenberg, Department of Parasitology of the Hebrew University for the determination of the trematode-cysts. I am deeply indebted to Dr. H. Steinitz, under whose guidance this work was done.—Dvorah Boschwitz, *Department of Zoology, Hebrew University, Jerusalem.*

TABLE 1

GIANT TADPOLES OF *Pelobates syriacus* COMPARED WITH NORMAL ONES

	Preserved Specimens at Same Stage of Development					
	Normal (formalin) N = 10			Giant tadpoles at capture May 29, 1956 (formalin) N = 6		
	Mean	Min.	Max.	Mean	Min.	Max.
Total length	95	85	107	170	142	186
Body length	38	35	45	65	47	75
	Living Individuals					
	Aug. 8, 1956 (8 weeks after capture) N = 10			Oct. 10, 1956 (17 weeks after capture) N = 8		
	Mean	Min.	Max.	Mean	Min.	Max.
Total length	181	160	205	182	175	195
Body length	77	65	85	82	75	85

THE CHORUS FROG, *PSEUDACRIS NIGRITA*, AT PLATTSBURGH, NEW YORK.—On May 4, 1956, four chorus frogs, *Pseudacris nigrita*, were collected by the writer in a drainage slough in Rugar Park, Plattsburgh, New York. This accumulation of water is not permanent, having at the time been recently filled by spring rains and thaw; it drains a small area of wet land, first as a widened trough, then abruptly as a narrow ditch shortly before reaching a steep embankment that forms the edge of the flood plain of the Saranac River.

The population was not large. There was never a chorus; single calls always being distinguishable. Probably no more than five or six were ever calling on the same evening. In the same area, spring peepers, *Hyla crucifer*, were numerous, and later American toads, *Bufo terrestris americanus*, became abundant. The latest date on which *P. nigrita* was heard was not recorded, but I believe it was as late as June 1. Many individual non-calling frogs were examined, but all were *H. crucifer*; no female *P. nigrita* were seen.

This report extends the known range of the species somewhat to the east and north. In recent compilations (Wright and Wright, 1949, Handbook of Frogs and Toads; Smith and Smith, 1952, Amer. Midl. Nat. 48: 165–180) the range of the subspecies *P. n. triseriata* is shown extending eastward through the Great Lakes to the eastern end of Lake Ontario, while *P. n. feriarum* ranges northward to

northern New Jersey. Smith and Smith (*op. cit.*) showed that the principal diagnostic character between these two subspecies, the ratio of tibia length to snout-vent length, was high for *triseriata* in the eastern Great Lakes, low for *feriarum* in New Jersey, the two regions being very similar in this character. Harper (1955, Nat. Hist. Misc. No. 150) has considered the latter population as a distinct subspecies, *P. n. kalmi*. This would cause difficulty in explaining the origin and taxonomic status of the Plattsburgh frogs, as their measurements indicate that they could reasonably be either of the extreme forms, and are not characteristic of either subspecies as they appear over most of their range. The tibia length of *feriarum* is usually 47% of snout-vent length or greater, that of *triseriata* usually less than 47%; the four Plattsburgh frogs range from 44.5% to 48.8%.

Most recently Smith (1957, Ecol. 38(2): 214–215) has given plausible evidence that the populations in the eastern Great Lakes region (called *P. n. triseriata* above) are probably intergrades, *triseriata* x *feriarum*, and that the New Jersey population (*kalmi* of Harper) is a relict population of *triseriata*, which subspecies, during the post-Wisconsin period, bisected the formerly continuous range of *feriarum* in eastern North America. Under this hypothesis, the Plattsburgh frogs offer no particular problems. They are probably a semi-isolated population of intergrades, which was once a part of the main eastern Great Lakes population.—ROBERT H. GIBBS, JR., *Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.*

THE STATUS OF *HETERODON BROWNI* STEJNEGER.—*Heterodon browni*, described by Leonhard Stejneger in 1903, (Proc. Biol. Soc. Wash., 16: 123–24) was based on three specimens collected by E. J. Brown at Lemon City (now Miami), Dade County, Florida. The specimens did not differ remarkably from the eastern hognose snake, *Heterodon platyrhinos* Latreille, in most features except all lacked the azygos plate. Since its original description *H. browni* has had a varied taxonomic history. In 1940 Carr (Univ. Fla. Publ., 3(1): 79) reduced it to a subspecies of *H. contortix* (= *platyrhinos*, Klauber, 1948, COPEIA, 1) and in 1952 (Chicago Acad. Sci., Nat. Hist. Misc. 112: 1–4) I noted, without detailed evidence, that *browni* appeared to be a synonym of *H. platyrhinos*. Schmidt and Davis (1941, Field Book of Snakes) were apparently the first to note that *browni* had a reduced number of dorsal body blotches; less than 20 according to their description. As Schmidt's recent sixth edition of the *Check List* (1953) retained this taxon as a race of *platyrhinos*, it seems of value even at this late date, to detail my reasons for considering it in the synonymy of *platyrhinos*. My paper, unfortunately, was published too late for inclusion in the Check List.

TABLE I

AZYGOS SCALATION IN FLORIDA *Heterodon platyrhinos*

Azygos	No. specimens	Percent
All Florida material		
Missing	10	9.5
Reduced	5	4.8
Normal	90	85.7
Total	105	100
Dade County only		
Missing	7	41.2
Reduced	3	17.6
Normal	7	41.2
Total	17	100

Three traits differentiate southern Florida *platyrhinos* from eastern hognose snakes in other parts of the range. In addition to the blotch counts and the azygos plate mentioned above, the number of ventral plates is lower in Florida. Dade County females average about 133 ventrals, males about 120; whereas females from northern Florida average about 136 and males 125. Through the rest of the range of the species and in Florida the ventral plates appear to vary clinally. Statistically there is a significant difference between ventral counts of males from Dade County and from northern Florida, however, among females such differences are not significant.

The dorsal blotches of *H. platyrhinos* decrease from north to south along the entire eastern seaboard in a fairly regular cline, reaching the lowest figure in Dade County. Again females show little change through Florida, whereas males have a more sharply depressed count.

Data on both ventral plates and dorsal blotches will be covered more fully in a subsequent paper on clinal variation in *H. platyrhinos*. Suffice it to say that both of these characters distinguish southern Florida *platyrhinos* from adjacent populations, but neither is an adequate diagnostic character.

Table I shows the results of a qualitative study of the azygos plate in Florida *platyrhinos*. A total of 105 Florida specimens was examined, and 10 of these completely lacked the plate, while five showed the azygos sufficiently reduced to be in striking contrast to the normal condition. When these two categories are lumped, a total of fifteen specimens, or about 14 percent shows the abnormality. Dade County material alone (Table I) shows an even higher proportion of snakes lacking the plate; seven of the ten lacking the scale are from this county. Thus about 41 percent shows the anomaly in its most extreme condition and an additional three show a reduced plate. Again when these categories are added, the percentage is increased to 59.

Michigan material may be used for comparative purposes. Of 83 specimens examined, only two show a missing or reduced azygos, 2.4 percent. This value

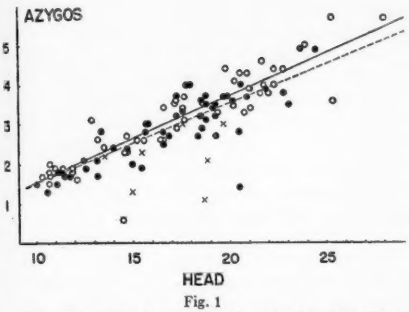


Fig. 1

Fig. 1. Regression of azygos length on head length of *Heterodon platyrhinos* from Michigan and Florida. Circles and solid line, Michigan; Dots and dashed line, Florida; x, Dade County. Measurements in mm.

Michigan: Azygos = −0.65 + 0.217 head length
Florida: Azygos = −0.52 + 0.201 head length

is significantly different from that for Florida snakes ($\chi^2 = 9.4878$, $p < 0.01$). In addition to the Florida and Michigan snakes, only three of over 1000 specimens examined from other parts of the range lack the scale.

Head length and length of the azygos plate were measured on a large number of *platyrhinos* from all parts of the range of the species. An index of head length was obtained by measuring from the posterior end of the interparietal suture to the tip of the rostral; the azygos plates were measured with calipers on larger specimens and with an ocular micrometer on smaller animals. The azygos lengths show a simple linear regression on head length (Fig. 1). Data for Florida (exclusive of Dade County) and Michigan specimens have been calculated separately. Both curves are strikingly similar and their slopes do not differ significantly (Michigan, $b = 0.217 \pm 0.041$; Florida, $b = 0.201 \pm 0.018$; difference, 0.016 ± 0.023; $p > 0.05$). Measurements of Dade County snakes also are plotted on Fig. 1. Four of these specimens fall within the scatter of Florida and Michigan specimens while three are below it. Specimens lacking the azygos would fall directly on the abscissa and have not been shown.

It is obvious from these studies that there is a morphologically definable entity in south Florida. Of approximately 1200 snakes examined, 15 lack the azygos plate completely. Of these, almost one-half come from Dade County. These data support the contention that Dade County hognose snakes differ from those from other parts of the range of the species, both in the condition of the azygos plate and in two clinal traits that present their most extreme condition in this area.

An additional feature of the original description must be noted. According to Stejneger, the type and paratypes have maxillary tooth counts of 8-2, which is lower than I encountered on 17 maxillae. Typically *platyrhinos* has a count of 10-2, although three specimens with 9-2 and two with 11-2 were seen. When the paratypes of *browni* were examined this characteristic was not specifically checked.

Evolution in the genus *Heterodon* appears to have progressed toward a small-headed, short-bodied burrowing morphology. It seems quite possible that the loss of the azygos and the possible reduction of the maxilla as indicated by decreased dentition may point toward a head-reduction in these forms. The lowered blotch and ventral counts may suggest body reduction.

The question of taxonomic recognition seems obvious. The ventral counts and body blotches represent clinal traits that hardly warrant systematic recognition, and the azygos trait alone permits allocation of only about 60 percent of the available material. In view of the 70–75 percent convention current in herpetology, this population, despite its obvious distinction, should not be recognized and the name *Heterodon browni* Stejneger must be relegated to the synonymy of *Heterodon platyrhinos* Latreille.—RICHARD A. EDGREN, *G. D. Searle & Co., P. O. Box 5110, Chicago 80, Ill.*

REVIEWS AND COMMENTS

HANDBOOK OF SNAKES OF THE UNITED STATES AND CANADA. By Albert Hazen and Anna Allen Wright. Comstock Publishing Associates, Ithaca, New York, 1957. 3 Volumes, xviii + 1105 pages, 306 figures, 70 maps.—This long awaited work is a welcome addition to the handbook series. The first two volumes include the Introduction and the Species Accounts. The third volume, the Bibliography, is not yet available, and its absence detracts greatly from the value of the two volumes in hand. The authors and the publishers should do all to hasten the publication of the bibliography.

The species account includes a discussion of the range, size, longevity, distinctive characteristics, color, habitat, period of activity, breeding, ecdysis,

food, venom, enemies, field notes and a list of authorities for each of the species and subspecies considered in the work. The accounts of genera and species are arranged alphabetically within the families. Each form is given approximately equal emphasis; the eight subspecies of the prarie rattlesnake (*Crotalus viridus*) are treated in 33 pages; the western diamondback rattlesnake (*Crotalus atrox*) is covered in seven.

The introductory section seems much too brief, only 31 pages followed by more than 1000 pages of species account. The discussions of size of adults, size of eggs and size of hatchlings, the consideration of breeding and courtship, ecdysis, the hemipenis and of food are good summaries of the information scattered through the species account and found in the general literature of herpetology. Hibernation and hibernacula, scalation, locomotion, collection and preservation methods are not treated. The important and growing literature on the influence of temperature on the distribution of reptiles in time and space is only briefly implied in the section on breeding.

The first six maps present general information on plant distribution, geological structure, physical divisions and mean annual isotherms. The distribution maps suffer from their generality and lack of indication of integradation. The photographs and line drawings are excellent and well chosen. There is however no way to tell if the specimen being illustrated is six inches or six feet long. The photographs alone are worth the price of the book.

The keys to the families are given on page 32. The keys to the genera are given separately under each family. The keys would have been helped if once a definitive position was reached the page to turn to was indicated. As arranged you must resort to the table of contents at each step or you must flip through the pages. Once you reach the form indicated by the key the figures are handy, but the map showing the ranges may well be 20 to 40 pages away. There is no table of maps and the maps are not indexed. The keys to the genera are well illustrated by handy line drawings.

The discussion of scientific and common names are enjoyable and adequate. The "313 species" indicated in footnote 1, page 2 undoubtedly refers to named forms (species and subspecies). The only definition of a species is that of the practical taxonomist. This definition is of course the one we must resort to in practice but it does tend to ignore the important contribution of herpetology to the biological definition of the species.

The comments on man as the greatest enemy of snakes are excellent and the discussion of the various methods by which man disrupts snake populations are well emphasized. A wealth of information on both snakes and snakeologists as seen from the experienced and critical eyes of this wonderful team is enjoyably and interestingly presented.

These two volumes, and the third volume, when available, are valuable additions to the library of the professional and amatuer herpetologist and at the same time will be useful to the many teachers of biology that are confronted with questions concerning "our lowly neighbors".—DAVID L. JAMESON, *Department of Zoology, San Diego State College, San Diego, California.*

TERRARIENKUNDE. 1. TEIL ALLGEMEINES UND TECHNIK. By Wilhelm Klingelhöffer. Second, completely revised edition issued by Christoph Scherpner. Alfred Kernen Verlag, Stuttgart. 1955. 167 pp., 1 col. pl. 75 figs. Paper cover. Price 13.50 Mark ($3.35).—Since 1931, when the first edition appeared, Klingelhöffer's manual has formed the vade-mecum of those professional and amateur herpetologists, who keep the animals of their interest in terraria. This revised and expanded second edition, which had to be completed by a collaborator after Klingelhöffer's death, continues to uphold its high standards and is stimulating reading, as well as forming an invaluable reference work.

The first volume deals with the general mechanics of starting and operating various types of terraria. Chapters cover the subjects of heat, light, construction of and arrangement of terraria, operation of terraria, the supply of food animals, collecting and shipping of terrarium animals, outside and fresh air terraria, glass houses for terraria, diseases of salamanders, frogs and reptiles, and the legal aspects.

The set is addressed mainly to German readers and the extensive literature citations (the list of "Literature cited" is unfortunately to be included in the fourth volume), appear to be primarily of German origin. There is also a tendency to refer to German medical and other trade names, which may complicate the task of using the prescriptions in other countries. The discussion of the diseases of terrarium animals should nevertheless be among the most useful and stimulating in the book, particularly for those who can supply the individual attention recommended here.

Even a brief inspection of this volume provides a graphic commentary on the vast step existing between the levels of European and American amateurs. Much of the emphasis over here has been on the keeping of animals in simple, easily cleaned cages with the owners being generally content with maintaining their specimens in feeding condition and tame enough to handle, preferably so tame that they will take food from the hand. Europeans on the other hand have accented the terrarium as a segment of the actual habitat, or a close approximation thereto, with the aim of persuading the

animals to pass their complete life cycle in captivity. One wonders how much of the different emphasis is due to the relatively greater abundance and variety of the herpetofauna of this continent, leading to emphasis on study in the field rather than in the laboratory—or living room. The latter certainly offers the opportunity of diverse types of observations, some of them difficult or impossible under wild conditions, as is evident from the pages of the numerous Aquarium and Terrarium Magazines appearing monthly in several European countries.—CARL GANS. *Museum of Comparative Zoology, Cambridge 38, Massachusetts.*

SNAKES AND SNAKE CATCHING IN SOUTHERN AFRICA. By R. M. Isemonger. Howard Timmins, Cape Town (dist. by Bailey Bros. & Swinfen Ltd., London). No date—1956? xii + 105 pp., 24 phot. pls. + figs.—This breezy volume is stated (p. ix) to have twin aims, to bring F. W. FitzSimons' "Snakes of South Africa" up to date and to interest "those on the look-out for thrills and laughs". It is a pity that the second aim has been accomplished so much more fully than the first.

The book may be divided into a part dealing with snakes in general and one listing different South African species. The first section deals with such subjects as "Snake catching", "Caring for snakes in captivity", "Some characteristics of snakes", "Snake venom and its effects", "Practical advice on first aid" and "Snake studying in natural surroundings", and also includes two chapters dealing with bites received—or narrowly escaped—by the author, who remarks that "suffering the consequences of snake poison is part and parcel of the study." The second section covers the more common snakes of the region, giving recognition characters, distribution and generally some remarks on habits as well. Many of these forms are illustrated with original photographs, though it should be noted that the specimens shown are often the Rhodesian rather than the South African representatives of wide ranging species. A final chapter "Snake knowledge from other sources" is mostly filled with quotations from Pitman's "Guide to the snakes of Uganda".

The volume makes pleasant reading but is replete with misleading to erroneous statements, some of which, such as the endorsement of permanganate of potash as a snake-bite treatment, as well as an eye wash to counteract the venom of the spitting cobras, are hardly of a minor nature. The items of most interest and value to this reader were the odd comments on snake habits, etc. scattered throughout the book and apparently the result of personal observation.—CARL GANS, *Museum of Comparative Zoology, Cambridge 38, Massachusetts.*

DIE LURCHE UND KRIECHTIERE EUROPAS. By Walter Hellmich. Winters naturwissenschaftliche Taschenbücher (no. 26), Heidelberg. 1956. 166 pp., 68 col. pls, 9 figs. Price approx. $2.25.—This slim, pocket-sized volume (a Taschenbuch as opposed to a Handbuch) attempts to present a joint field guide and reference work to the entire European herpetofauna. It is not too surprising that it falls somewhat short of this ambitious goal. Yet in spite of various defects and of the very uneven treatment (certain subspecies are discussed in detail, while full species or even genera are dismissed with brief mention) the reasonably-priced book with its many colored plates should make a rather useful addition to a herpetological reference shelf. Its small size should adapt it to the needs of a herpetologist visiting Europe.

In taxonomic treatment the volume follows the checklist of Mertens and Müller (1928, Senck. Abhandl. vol. 41) with additions. Hellmich records four species whose ranges were extended into Europe and omits the same number given in the old list. Outside of the genus *Lacerta* he records 26 new and omits two old races.

There is generally some description of each form, often followed by remarks on range, habits in and out of captivity and on taxonomic history and races. Emphasis is on central European forms as well as on common ones, while the illustrations were drawn from life so that they had to figure mainly local and more readily available species. There are no keys and few text figures and identification has to be by elimination. This task is complicated by the peculiar composition of the text. In order to have each description facing the corresponding plate, the discussions of forms have been given in an order different from their citation in the introduction, even out of generic context. The ends of certain sections were placed into the middle of others.

The introductory section again suffers from the attempt to cover too much territory in too small a space. The most distressing error to this reader was the repeated use of humerus for femur and of femur and tibia for tibia and fibula (p. 12 and fig. 2). It was not possible to shake off the impression that the varied anatomical and other information and much of the taxonomic detail did not belong in a field guide of this size. Certain tasks are impossible to the best of writers and this volume would have gained from a restriction of scope, possibly coupled with a more uniform coverage of all European species.—CARL GANS, *Museum of Comparative Zoology, Cambridge 38, Massachusetts.*

THE AMPHIBIA OF CEYLON by P. Kirtisinghe. Published by the author, 2 Charles Circus, Colombo, 3. 1957. xiii + 112 pp., 1 pl., 74 text-figs.—Though the amphibian fauna of Ceylon is small (thirty-two species recognized by Kirtisinghe), its high degree of endemism (twelve species) gives it

considerable interest. Consequently, this review by Kirtisinghe, a Lecturer in Zoology in the University of Ceylon, should be welcomed by herpetologists and zoogeographers, especially since the last previous review was Boulenger's Fauna of British India (1890).

Kirtisinghe presents a brief historical account of the study of Ceylonese Amphibia from the illustration of *Serpens Caecilia Ceylonica* in Seba's Thesaurus (1735) to Wolf's revision (1936) of *Rhacophorus*. The remainder of the book is taxonomic and includes keys to the families, genera, and species and even to the known larvae, making the work a useful one both in the field and in the museum laboratory. Each species account consists of synonymy, description and figure of adult, range, and description and figure of larvae when known. The descriptions are clear and diagnostic; the figures are accurate (as far as the reviewer has been able to compare them with specimens) and well-executed.

The taxonomy, based on the author's personal collection and on the collections of the British Museum, is reliable on the whole, and Kirtisinghe has heeded the warning of a herpetological Polonius to "neither a splitter nor a lumper be." However, one may question the wisdom of treating *Rana greeni* Boulenger (known only from Ceylon) as a subspecies of the wider ranging *Rana limnocharis*, particularly in view of the facts that the typical form occurs all over Ceylon and that the two larvae are not identical. Conceivably, these two ranids are related subspecifically and the present occurrence of *R. l. limnocharis* in Ceylon may be a recent development.

The failure even to discuss this and other problems of speciation is one of two disappointing omissions. The other is the lack of ecological information. Though one may regret these omissions, the work is nonetheless a sound and useful contribution.—ROBERT F. INGER, *Chicago Natural History Museum, Chicago, Illinois.*

RYBY BASSEINA AMURA (Fishes of the Amur basin). Itogi Amurskoi ikhtiologicheskoi ekspeditsii 1945–1949. Akademiya Nauk SSSR, Moscow, 1956, 551 pp., 60 figs., 244 tables, errata sheet inserted, by G. V. Nikolskii. (In Russian.)—The Amur basin comprises one of the largest watersheds in Eurasia and is the largest system draining into the Sea of Okhotsk. Nikolskii's book treats, evidently quite thoroughly, each of the 103 species which are found there. No new forms are named. Twenty-two families are represented, with the Cyprinidae being most speciose (51 species in 34 genera), followed next by the Salmonidae (12 species in 6 genera), Cobitidae (5 species in 5 genera), and the Bagridae (4 species in 2 genera).

The book opens with a short introduction, followed by an outline of the history of ichthyological research on the Amur basin. The bulk of the text, 448 pages, is devoted to accounts of the fishes. Keys are provided for the identification of families and for the species in those families represented by more than one form in the Amur.

Chapters follow which are concerned with the composition, origin, and distributions of Amur basin fishes (pp. 464 ff.); factors governing their reproduction (pp. 483 ff.); food relations (pp. 491 ff.); factors controlling growth and dynamics of schools (pp. 498 ff.); migration and wintering (pp. 504 ff.; table 240, pp. 510–511, outlines the types of migrations in Amur fishes, from egg to adult); and a biological basis for the sensible commercial exploitation of schools (pp. 513 ff.). Nikolskii seems qualified to comment upon the foregoing topics since he has published numerous articles on schooling, migration, and reproduction in freshwater fishes.

The bibliography, 11 pages in length, contains 354 entries. Of these only 90 were not published in Russian and of the 90 fewer than 65 were written by non-Russian workers. This is not particularly surprising since most of the Amur basin has been in Russian hands for centuries and its ichthyological exploration by the Russians began in 1772 with the work of Petr Simon Pallas.

On pages 542–547 the author summarizes in tabular form the relative abundance of each fish in different segments of the Amur basin and indicates in which type of habitat the *nagul* is spent. *Nagul* refers to that phase of the life history which is concerned with feeding and fattening before the onset of the spawning migration; it is a useful term for Western students to employ, as we appear not to have any one word to impart this concept.

As a minor criticism, the reviewer was somewhat surprised to read that the Soviet Union contains three river systems longer than the Nile (see table 241, p. 515; taken from a paper published by Rass). The Ob' is stated to be 13,723 km. in length (about 8,500 miles), the Amur is 9648 km. in length (about 6000 miles), the Yenesei is 8215 km. in length (about 5100 miles); if the length of the Nile is taken as 4000 miles, even the Mississippi is longer according to the table (6793 km., about 4200 miles). Rass must have erred in computing river lengths.—VLADIMIR WALTERS, *The American Museum of Natural History, New York 24, N. Y.*

THE LIVING SEA. By John Crompton. Doubleday & Company, Inc., Garden City, N. Y., 1957; 234 pp., 24 figs.; $3.95.—This is written in popular though somewhat sensational style. The material is treated superficially compared to Carson's "The Sea Around Us". The numerous erroneous statements detract from the value of the book. Readers interested in aquatic biology will be dis-

mayed to find an appreciable portion of the work devoted to terrestrial life.

FRESHWATER FISHERY BIOLOGY. By Karl F. Lagler. Second edition. Wm. C. Brown Company, Dubuque, Iowa, 1956; xii + 421 pp., 184 figs.; $6.75.—The first edition was reviewed in Copeia (1953: 69–70). The textual matter has been brought up to date and many illustrations have been replaced. It is surprising to encounter the statement that *Dallia pectoralis* "can remain frozen for days, and when thawed will be as lively as ever." This myth has been disproven by several investigators during the past quarter century. The minor criticisms raised by the reviewer of the first edition can be applied to the new edition, with appropriate pagination changes. The present edition is an improvement upon the first, which was in itself a fine book.

WORLD SEA FISHERIES. By Robert Morgan. Pitman Publishing Company, New York, and London, 1956; xiv + 307 pp., 16 pls., 61 figs.; $6.95. As with many British books there is no year of publication given though this seems to have been released in 1956. The subject matter is almost entirely economic, as the title implies. Aside from this the textual matter is informative and interestingly written as an ecological study of sea fisheries.

THE ORIGIN OF THE VERTEBRATES. By N. J. Berrill. Oxford University Press, London, 1955: viii + 257, 31 figs. $3.00.—Whether Berrill's thesis regarding vertebrate origins is right or wrong will, as the author himself points out, probably never be known. In any event, the book can be highly recommended as a fine piece of biological writing.

COTTOID FISHES OF LAKE BAIKAL. By D. N. Talief. Russian Academy of Sciences Press, Moscow and Leningrad, 1955: 603, 179 figs. (In Russian.)—This is undoubtedly the most intensive and extensive account of a "species flock" that has ever been written. The 37 forms dealt with seem to have been taken up from every conceivable angle.

EDITORIAL NOTES AND NEWS

SUMMARY OF 1957 MEETING

THE thirty-seventh annual meeting of the ASIH was held at the Jung Hotel, New Orleans, Louisiana, April 18–21, 1957. The hosts were primarily recruited from the Department of Zoology of Tulane University.

EVENTS OF WEDNESDAY, APRIL 17

DR. and MRS. FRED R. CAGLE entertained members of the Board of Governors at a reception at their home in the evening. Cocktails and a delicious Creole-style buffet supper were served and the meetings off to a spirited start.

EVENTS OF THURSDAY, APRIL 18

After registration, members and guests assembled for the first technical session at 9:00 a.m. PRESIDENT EDWARD H. TAYLOR greeted the members and suggested that far more of value would be learned by attending the sessions than in other distracting activities. The following papers were presented:

The Distribution of Florida Marine Fishes. John C. Briggs, University of Florida.

Sexual Dimorphism in a Population of *Crotalus atrox*. Don R. Boyer, Tulane University.

A Taxonomic Analysis of the Lantern-fish, *Myctophum affine*, in the Western Atlantic. Robert H. Gibbs, Jr., Woods Hole Oceanographic Institution.

The Number of Vomerine Teeth as a Systematic Character in *Plethodon*. Richard Highton, University of Maryland.

Some Aspects of the Study of the Postlarval Development of Marine Fishes. Gilbert L. Voss, University of Miami.

Collecting *Hydromantes italicus* and *Proteus anguinus* in the Caves of Italy and Yugoslavia. James Kezer, University of Oregon.

The Systematics of the Shore Brotulids with Free Caudal Fins. Boyd W. Walker, University of California, Los Angeles.

In the afternoon, KARL P. SCHMIDT presided over the Herpetological Section where the following topics were discussed:

Preliminary Results of Crosses between Altitudinal Races of the Pacific Tree Frog, *Hyla regilla*. David L. Jameson, University of Oregon.

***Bufo canorus*—a Study in Adaptation to a Montane Existence. Ernest L. Karlstrom, Augustana College.**

Evolutionary Patterns in the Snake Genus *Atractus*. Jay M. Savage, University of Southern California.

Taxonomy and Distribution of the Box Turtle, *Terrapene ornata*. John M. Legler, University of Kansas.

Record Life-span for a Small Snake. George P. Meade, Gramercy, Louisiana.

An Analysis of the Herpetofauna of Eastern Canada. Sherman Bleakney, National Museum of Canada.

Notes on Feeding Habits of the Northern Water Snake. E. E. Brown, Davidson College.

The Relationships of Two Forms of *Pseudacris nigrita* in Southwestern Georgia. John W. Crenshaw, Jr., Antioch College.

Some Comments on a Checklist of Amphibians and Reptiles. Percy Viosca, Jr., New Orleans.

Concurrently, EDWARD C. RANEY presided over the Ichthyological Section where the following papers were heard:

Variation and Relationships of the Minnows of the *Notropis whipplei analostanus chloristius* complex. Robert H. Gibbs, Jr., Woods Hole Oceanographic Institution.

Status of the Cyprinid Species *Moniana deliciosa* Girard and *Cyprinella texana* Girard. Royal D. Suttkus, Tulane University.

The Relationships of the Genera of the Blennioid Fish Family Tripterygiidae. Richard Rosenblatt, University of California, Los Angeles.

Current Status of Knowledge of Istiophorid Fishes. C. Richard Robins, University of Miami.

Environmental Effects on the Lateral Line Counts of *Etheostoma lepidum* and *E. grahami*. Kirk Strawn, Lamar State College of Technology.

Sexual Photoperiodicity of the Cyprinid Fish, *Notropis bifrenatus* (Cope). Robert W. Harrington, Jr., Florida State Board of Health.

The annual meeting of the Board of Governors of the Society convened at 8:00 p.m. with forty governors present. Earlier in the day PRESIDENT TAYLOR had thoughtfully issued a general invitation to the membership to observe the governors' deliberations and about thirty members were sufficiently interested to remain through the duration of the Board meeting. This procedure was most desirable for it provided the general membership an opportunity to become more intimately acquainted with the problems facing the Society.

With PRESIDENT TAYLOR in the chair, SECRETARY GROBMAN read messages from the following absentee members of the Board: A. P. BLAIR, FRANCES CLARK, N. B. GREEN, CARL HUBBS, LAURENCE KLAUBER, KARL LAGLER, JOHN MARR, ROBERT MILLER, JAMES OLIVER, BOBB SCHAEFFER, RICHARD SNYDER, WILLIAM STICKEL, JOHN TEE-VAN, VADIM VLADYKOV, and RALPH YERGER.

The minutes of the 1956 meeting were approved as published in *Copeia*, 1956 (4): 270–275.

Ten persons were elected to the Board of Governors for the class of 1962, as follows: EUGENIE CLARK, WILLIAM CLAY, COLEMAN GOIN, ARNOLD GROBMAN, ROBERT HARRINGTON, CLARK HUBBS, ROBERT INGER, NEIL RICHMOND, RICHARD ROBINS, and RICHARD ZWEIFEL.

Since no vacancies were reported among the roster of honorary foreign members, no new foreign members were elected.

MR. WOODS, Vice-President for Conservation, then gave his report. He knew of no emergency situations that had not been adequately handled by another organization during the year. He asked members to help him keep informed on conservation problems.

The report of the Vice-President for Membership, DR. A. P. BLAIR, was read by the Secretary, who commented upon it. The present drive is to increase subscriptions at those institutions where the Society has members but the library does not receive *Copeia*.

DR. FRED CAGLE, Editor-in-Chief, then gave a detailed report. The major problem he discussed was the difficulty involved in the present administrative machinery in publishing Copeia. The great distances separating the present editors, and the problems arising from the authority divisional editors have in accepting manuscripts while the Editor-in-Chief is restricted by his budget in the amount that can be printed, were considered by DR. CAGLE to be overwhelming obstacles to the prompt and orderly publication of *Copeia*.

After considerable earnest discussion, it was generally agreed that the two divisional editors and the small editorial board should be replaced by an enlarged editorial board. DR. DAVIS then moved an amendment to the Constitution incorporating this proposal which was seconded by MR. BOGERT. After some modification, the following proposed amendment to the Constitution was passed with one dissenting vote:

The last phrase of Article IV, Section 1 of the Constitution is amended to read "... an Editor-in-Chief and an editorial board of twenty-two of whom one shall be a book review editor, one an index editor, ten shall be ichthyologists, and ten shall be herpetologists, each of whom shall be elected annually but who may serve unlimited consecutive terms."

With an enlarged editorial board, MR. CONANT pointed out that the Executive Committee, defined as consisting of the officers, might well be too unwieldy. After some debate, DR. GOIN moved that the Constitution be amended to more clearly designate the composition of the Executive Committee. His motion was duly seconded and passed unanimously. The motion was to amend Article IV, Section 7 of the Constitution to read, "The Executive Committee shall consist of the President, Vice-Presidents, Secretary, Treasurer and Editor-in-Chief."

After some discussion, the consensus emerged that it was not desirable to add volume numbers to *Copeia*.

In the absence of PUBLICATIONS' SECRETARY GREEN, the Secretary presented his report. Since his previous annual report, $835 worth of back numbers of *Copeia* had been sold. Many numbers

are no longer in stock. The sales of the Herpetological Check List have been disappointing but a flurry of orders resulting in about 50 sales followed an advertisement in the *A. I. B. S. Bulletin*. Sales amounted to $221 for the year. In addition to the Check List and back numbers of *Copeia*, Dr. Green also distributes *Ichtherps*, *Dopeia*, and the List of Herpetological Common Names.

The problem of advertisements and reviews was discussed and it was moved by DR. GOIN, seconded and carried that an advertisement be placed in *Nature Magazine* for the Herpetological Check List and the List of Herpetological Common Names.

PRESIDENT TAYLOR then requested DR. NETTING to assume the responsibility of encouraging the review of the Check List in suitable journals.

TREASURER GOIN then presented his report for calendar year 1956, as follows:

Financial Report for Calendar Year 1956

CHECKING ACCOUNT

Balance on hand, Citizen's Bank of Gainesville, Jan. 1, 1956		$2,670.00
RECEIPTS		
Memberships Received		
Current dues for 1956	1,178.50	
Back dues, 1955	14.50	
Advance dues, 1957 and beyond	5,168.77	
		6,361.77
Subscriptions Received		
Current for 1956	1,190.54	
Advance, 1957 and beyond	1,948.83	
		3,139.37
Back numbers of *Copeia* sold		
Publications Secretary (Huntington)		536.12
Interest—Stoye Fund Bonds		77.60
Interest—Endowment Fund Bonds		130.20
Contributions		
Anonymous (Dunn Memorial Number)	100.00	
Carl L. Hubbs (Western Division Prizes)	25.00	
L. M. Klauber (Western Division Prizes)	25.00	
Tracey I. Storer (Printing)	25.00	
Giles Mead	35.00	
Clark Hubbs	25.00	
L. M. Klauber	25.00	
S. R. Atsatt	25.00	
A. E. Daughtery	25.00	
C. M. Bogert	25.00	
Roger Conant	25.00	
Hubert O. Jenkins	20.00	
W. H. Woodin	15.00	
Frances N. Clark	15.00	
E. Trewavas	15.00	
Robert R. Miller	11.00	
Francis M. Uhler	10.00	
William Hall	10.00	
Earl S. Herald	10.00	
Robert C. Miller	10.00	
Waldo L. Schmidt	10.00	
Harold H. O'Connell	10.00	
K. Carlander	10.00	
E. B. S. Logier	10.00	
B. Lutz	10.00	
James Atz	10.00	
Raymond Johnson	10.00	
Cincinnati Soc. Nat. Hist.	10.00	
Miscellaneous contributions	207.00	
		763.00
Charges for use of Mailing List		15.00
Refund from Secretary (travel to Higgins Lake)		16.00
Return from Annual Meeting		58.21
Total		$13,767.27

EXPENDITURES AND DISBURSEMENTS

Cost of publication of *Copeia*		
1956, no. 1	$1,788.01	
1956, no. 2	1,837.88	
1956, no. 3	1,460.53	
		5,086.42
Printing		351.07
Stenographic Services, Secretary, Gainesville		149.00
Social Security		6.00
Postage and Incidentals		
Secretary	125.00	
Editors	25.00	
		150.00
Contributions		
Remittance of 40 pounds to Zoological Society to assist in publication of "Zoological Record"		113.60
Treasurer's bond, 1956		5.00
Travel, Secretary, Higgins Lake		200.00
N. R. C. booklet		62.00
Binding Editor's set of *Copeia*		8.24
Refunds for overpayments		38.00
Index of *Copeia*		8.17
Ad for Check List in AIBS Bulletin		50.00
Bank charges		26.93
Dues, AIBS		822.00
Stoye prizes		
Donn Eric Rosen (1st Prize, Ich., Higgins Lake)	$25.00	
Richard H. Rosenblatt (2nd Prize, Ich., Higgins Lake)	15.00	
Bruce B. Collette (1st Prize, Herp., Higgins Lake)	25.00	
M. M. Ali (1st Prize, Ich. Western Div.)	25.00	
Ernest L. Karlstrom (1st Prize, Herp. Western Div.)	25.00	
		115.00
Total Expenditures		$7,191.43
Balance on hand, Citizen's Bank, December 31, 1956		6,575.84
Total		$13,767.27

ENDOWMENT FUND

Balance on hand, First Federal Savings and Loan Association, January 1, 1956	$2,574.88
Received from Life Members	1,155.00

Received from sale of Check List	199.42
Interest	70.41
Total	$3,999.71
Purchase of two $1000.00 Series K Bonds	2,000.00
Balance on hand, First Federal Savings and Loan Association, December 31, 1956	$1,999.71

REVOLVING RESEARCH FUND

Balance on hand, Florida Bank of Gainesville, January 1, 1956	$465.25
Gift	5.00
Total	$470.25
Grant to Walter Auffenberg	250.00
Balance on hand, Florida Bank of Gainesville, December 31, 1956	$220.25

DR. GOIN then gave some further information on the financial status of the Check List venture. The cost of publishing the Check List was $4,227, of which $2,085 had been borrowed from the Endowment Fund with the requirement that as sales were made, the Endowment Fund would be repaid first. Sales to date have so far totaled $1,761, which amount has been deposited back in the Endowment Fund.

PRESIDENT TAYLOR then called for the report of the Auditing Committee. DR. DOWLING, in the absence of DR. MARCHAND, Chairman, read the report as follows:

"The auditing Committee has audited the books of the Treasurer and finds the accounts in order. All credit memoranda from the Secretary have been inspected and all vouchers for monies disbursed have been verified. The bank deposit record has been examined and monies have been deposited regularly. The Auditing Committee wishes to commend COLEMAN J. GOIN for the evident care with which he has administered the office of Treasurer.

"The auditing Committee makes the following recommendations in order to facilitate the work of the Treasurer:

"1. That a standard mimeograph form should be adopted to account for the receipt and dispersement of all monies. These forms should be numbered consecutively upon use by the Treasurer and should show the source of all monies obtained and the bank deposit slip upon which entered, or if a disbursement, the supporting check number. To this form should be stapled any supporting papers such as personal letters or vouchers.

"2. All monies received by the Treasurer should be deposited in the checking account, and if transferred to the Endowment Fund or Revolving Research Fund is desired such transfer should be effected by a check drawn against the checking account.

"3. Duplicate deposit slips should be retained by the Treasurer."

The Secretary then presented the report of the Vice-President for Finance in DR. MARR'S absence. DR. MARR'S principal recommendation was that the Society turn surplus funds over to an investment trust for handling instead of investing them in government bonds as has been the custom. DR. GOIN then moved that the report be accepted. It was duly seconded and passed. It was brought out in the discussion that implementation would be the responsibility of the next Treasurer and the Vice-President for Finance.

PRESIDENT TAYLOR then asked for a report from the Special Committee Studying Costs of ASIH. DR. INGER gave a careful comparison of the budgets and activities of the ASIH and the American Society of Mammalogists. He concluded his report with a recommendation designed to increase the Endowment Fund. Although there was considerable involved discussion, the eventual result was to refer the report to the Vice-President for Finance for study prior to the next annual meeting.

PRESIDENT TAYLOR then called upon the Secretary for his report. DR. GROBMAN reported as follows:

"The work of the Secretary, under the present structure of the Society, involves a great many routine tasks. These primarily include the collection of dues (in a variety of categories) and subscriptions and the accompanying rendering to the publishers of accurate mailing lists. The Secretary also authorizes all disbursements of Society funds. He distributes occupational literature in the fields of ichthyology and herpetology. He is also responsible for preparing the Agenda for the Board of Governors' meetings and for preparing the minutes of annual meetings of the Society for publication in *Copeia*. He conducts occasional polls of the membership as requested by the governors. He assists the local committee planning for the annual meeting and mails out the "call for papers." He is able to hire some clerical help and his expenses to the annual meeting are borne by the Society.

"While much of his work is routine, there are two areas in which some exercise of judgment is required. One of these is correspondence with members, prospective members, subscription agencies, and libraries. In the middle of his term in office, your present Secretary was given a new assignment by his University with the result that the amount of time he could devote to Society affairs was drastically reduced. In an attempt to compensate for this, increased use was made of form letters to handle much of the Society's correspondence. In some other instances, letters received briefer and less prompt replies than your Secretary liked. He

regrets that personal contact between his office and the membership was less than had previously existed and apologizes for having done less well in this matter than he would have liked.

"Another phase of the work of the Secretary, that is not primarily routine, is to serve as business manager of the Society. In this phase of the job, your Secretary feels that he has made a significant contribution to the welfare of the Society.

"It has been difficult for the Society to operate on a businesslike basis because of fluctuating economic conditions, the lack of adequate capital reserves, and the restricted amount of time secretaries could give to the Society. In the past, the Secretary has prepared annual operating budgets but they were not always realistic for three important reasons: (1) The Secretary could not accurately predict increases or decreases in numbers of members and subscribers; (2) he could not anticipate rising printing costs; and (3) expenses for *Copeia* were primarily determined by the number of manuscripts received rather than on a fiscal basis. About three years ago the present Secretary made a detailed study of the postwar financial operations of the Society and, as a result of this investigation, recommended a fiscal policy for the Society that was adopted by the Board of Governors at San Francisco.

"Briefly, this policy calls for an annual operating budget based on the preceding year's operations. The main feature is that the budget for publishing *Copeia* in any one year is an amount equal to 76 per cent of the income of the preceding year.

"These arrangements automatically adjust for fluctuations in membership and subscriptions and for changes in printing costs.

"Should the number of manuscripts received be greatly increased or greatly diminished, recourse could be had by raising or lowering the dues. The present dues schedule seems realistic, however, and the Secretary recommends that it be continued unchanged for at least another year.

"Should the Society be greatly reorganized—such as a tremendous increase in membership or the hiring of a salaried official—the value of 76 per cent could be appropriately adjusted.

"Thus your Secretary believes the operational policy is sound and flexible and it should continue to provide a basis for a realistic and efficient operation of the Society's affairs unless the nation suffers a tremendous economic upheaval.

"In many ways, the ASIH is in a difficult administrative position. The secretarial work of a society with a few hundred members can readily be handled by a faculty member without putting great demands on his time. A society with a few thousand members can afford a salaried secretary. With about 1400 members, the ASIH is in-between the two positions that can be handled easily. We are too large for the work to be handled readily in the spare time of a busy person and too small to be able to pay the salary of a Secretary.

TABLE I

EXPENDITURES AND RECEIPTS FOR 8-YEAR PERIOD BY MAJOR CATEGORIES

	1949	1950	1951	1952	1953	1954	1955	1956	
Receipts									
Dues	4297	5788	4377	5731	5259	4636	5287	6362	
Subscriptions	1050	1542	1639	2095	2088	2150	2085	3139	
Back Numbers	352	147	1870	1012	1012	831	823	536	
Contributions	165	292	278	131	125	2	484	763	
Total Receipts	5864	7769	8164	8969	8484	7619	8679	10800	
Expenditures									
Copeia	5081	4797	6067	6127	7243	6624	7252	6956	
Secretary	803	458	445	687	914	1019	703	663	
Publ. Secretary	0	50	36	0	89	0	7	50	
Editors	120	60	50	147	50	103	150	32	
Annual Meeting	154	104	125	180	190	15	450	200	
Zoo. Record	102	142	282	140	114	114	114	114	
AIBS	615	752	794	814	765	667	696	822	
Miscellaneous	41	86	8	63	0	10	0	108	
Total Expenditures	6916	6449	7807	8158	9365	8552	9372	8945	
Annual Net Loss	1052				881	933	693		3559
Annual Net Gain		1320	357	811				1855	4343

"An accompanying table gives a brief financial analysis of operations for the last eight years (Table I). Notice that fiscal 1956, the first full year under the new operational policy, has left the Society in a comfortable financial situation. And *Copeia* contained just as many pages as had been normal during the last eight years despite an increase in printing costs from $15.37 per page in 1949 to $19.43 in 1956.

"There were many forebodings at the beginning of the year. It was felt by some that raising dues one dollar (to $8 for domestic members) would greatly decrease the number of members. Fortunately, this fear did not materialize. There has actually been a substantial increase in the number of members during the last year.

"Under the operational policy adopted at San Francisco, the budget available to publish *Copeia* during 1956 was set at $6,000. (Rounded figures are used in these paragraphs.) This would have permitted a balanced budget for the year. The Editor-in-Chief did not think this sufficient and requested the Board of Governors at Higgins Lake to increase the budget for 1956 *Copeia* by $1500. The Board agreed and decided that the additional

funds would be sought in two ways: (1) by calling for contributions from members and (2) by applying for a foundation grant to make up for the anticipated deficit.

"A most favorable chain of events occurred during the year. As already mentioned, the number of members and subscriptions increased and $1800 more was received from these sources than was anticipated. Of the additional $1500 appropriated by the Board for *Copeia*, only $600 was actually spent. The members generously gave $600 in unearmarked contributions as a result of the appeal made by the Secretary. The National Science Foundation made available a grant of up to $700 towards the anticipated deficit in the publication of *Copeia*.

"Fortunately, the deficit did not materialize. The grant from the National Science Foundation was not needed and was declined with thanks. The members' contributions were also, happily, not needed to apply against a 1956 deficit but are, instead, being used to enlarge *Copeia* for 1957.

"Much of this report has been devoted to certain features and applications of the new operational policy. The reason for this has been to emphasize the basic soundness of the policy. Your retiring Secretary strongly urges that this policy be used as a guide in the Society's fiscal operations for years to come.

"In round numbers, the Society now has about 950 domestic members (about 100 are life members); 250 domestic subscribers; and approximately 230 foreign members and subscribers. In recent years, we have enjoyed a net gain of about 25 members annually.

"The Secretary enjoyed cordial working arrangements with the other officers of the Society, particularly with the President and Treasurer. He greatly appreciates the help he has received from CHARLES BOGERT, EDWARD RANEY, and COLEMAN GOIN.

"Your Secretary has enjoyed his term in office. He was not able to satisfy everyone he had contact with. While he realizes that this is inevitable, he sincerely regrets not having been able to achieve such a goal.

"Frankly, he would rather have worked on salamanders than devote the time to secretarial duties. However, he derives some consolation—and some satisfaction—in feeling that his service as Secretary of the Society has, albeit indirectly, helped advance our knowledge of the cold-blooded vertebrates."

The report was approved.

SECRETARY GROBMAN then reported upon the poll of membership regarding association of ASIH with AIBS. The results were that 78% (of 358 members voting) preferred to continue full membership of ASIH in AIBS; 13% preferred to change to affiliation; and 9% preferred to sever all connections. It was moved and seconded that the report be accepted and it was so ordered by the President.

PRESIDENT TAYLOR then announced that it was customary for the Society to donate 40 pounds to the Zoological Record. An appropriate motion was made, seconded and carried.

Brief reports were then heard from the Western Division and the Southeastern Division.

In the absence of MR. COATES, DR. HERALD gave a report for the Committee on Aquaria. The principal item in the report was that the Committee plans to work on a volume on large-sized aquaria.

MR. CONANT spoke briefly for the Committee on Herpetological Common Names and said he would give a full report at the Business Meeting of the Society.

DR. SAVAGE then read the report of the Committee on Nomenclature in DR. FOLLETT'S absence. The report follows:

"The present Committee on Zoological Nomenclature consists of ROBERT RUSH MILLER, JAMES A. PETERS, JAY M. SAVAGE, HOBART M. SMITH, NORMAN J. WILIMOVSKY, and W. I. FOLLETT, chairman.

"During the past year, the Committee has completed its consideration of the following propositions, and has reported its consensus thereon to the International Commission on Zoological Nomenclature:

"1. The Committee unanimously supported the application of Mr. Denys W. Tucker (1955, Bull. Zool. Nomencl., 11(9): 285–288) for use of the Plenary Powers to suppress the generic name *Acinacea* Bory de St. Vincent, 1804, and the specific name *notha* Bory de St. Vincent, 1804, as published in the combination *Acinacea notha*, for the purpose of making the generic name *Gempylus* Cuvier, 1829, and specific name *serpens* Cuvier, 1829, as published in the combination *Gempylus serpens*, the oldest available names for the genus and species concerned.

"2. The three herpetological members of the Committee, together with the President of the Society as an ex-officio member, were equally divided in their support of (1) the proposal by Duellman (1956, Bull. Zool. Nomencl., 12(5): 143–146) for the suppression of the specific name *venulosa* Laurenti, 1768, as published in the combination *Rana venulosa*, and (2) the counter-proposal by Mertens (1956, Bull. Zool. Nomencl., 12(10): 287), and independently by Smith (1956, Bull. Zool. Nomencl., 12(11): 307–308), for the exercise of the Plenary Powers to fix the name *venulosa* Laurenti, 1768, upon the species named *Hyla zonata* Spix, 1824. In view of this division of herpetological opinion, the three ichthyological members of the Committee have deemed it appropriate to refrain from voting on this problem.

"3. A request from the Secretary of the International Commission on Zoological Nomenclature for the views of the Committee on the problem of the relative priority to be accorded to the names *Cheirodon axelrodi* Schultz, 1956, and *Hyphessobrycon cardinalis* Myers and Weitzman, 1956 (see 1956, Bull. Zool. Nomencl. 12(6): 184–190), was referred to the members of the Committee and to 22 representative ichthyologists throughout the United States, with the request that they communicate any information or suggestions directly to the Secretary of the International Commission.

"4. William A. Gosline, Ichthyological Editor of COPEIA, requested the Committee's advice as to the proper interpretation of the provision that *-i* and *-ii* as terminations of the genitive singular in specific names are to be deemed permissible variants without nomenclatural significance (Copenhagen Decisions on Zoological Nomenclature, 1953: 54). This query was referred to the Secretary of the International Commission on Zoological Nomenclature, who expressed the opinion that, as enacted, this provision permits the original author to use the termination *-i* or *-ii* as he may prefer, but requires subsequent authors to adhere to the usage employed by the original author, since a change from *-ii* to *-i* by a subsequent author would constitute an invalid emendation (Copenhagen Decisions on Zoological Nomenclature, 1953: 44). A majority of the Committee members voting on the problem expressed their approval of this interpretation, for specific names heretofore published.

"Dated: April 11, 1957."

The report was accepted.

Discussion about the site for the 1958 meeting began with a report by DR. LACHNER of the planning for the Linneaus Bi-Centennial celebration to be held in Washington in December, 1958, in conjunction with the AAAS meetings. The consensus was against a December meeting in Washington and, after some discussion, it was decided to have the site and time of the 1958 meeting determined by the Executive Committee.

DR. NETTING announced that the American Committee for International Wildlife Protection, which has published books on rare and vanishing mammals and birds, would like to do similar volumes on cold-blooded vertebrates. He asked that persons interested in preparing parts of such volumes contact him.

In view of their retirement from office at the end of 1957, SECRETARY GROBMAN and TREASURER GOIN were given a vote thanks by the Board.

The meeting adjourned at 11:00 p.m.

EVENTS OF FRIDAY, APRIL 19

Split sections began at 9:00 a.m. JOSEPH R. BAILEY presided over the Herpetological Section where the following papers were heard:

An Ecological Life History Study of the Copperhead. Henry S. Fitch, University of Kansas.

Ramifications of Studies on African Frogs. Karl P. Schmidt, Chicago Natural History Museum.

Temperature Responses and the Ecological Relations of Two Bornean Skinks. Robert F. Inger, Chicago Natural History Museum.

Frogs of the Genus *Physalaemus* in Southern Brazil. William W. Milstead, Sul Ross State College.

Rattlesnakes in New Orleans. Percy Viosca, Jr., New Orleans.

Metachrosis in Frogs of the *Hyla miotympanum* Complex. William E. Duellman, University of Michigan.

Group antigens in the Venoms of *Agkistrodon, Sistrurus,* and *Crotalus*. Sherman A. Minton, Indiana University Medical Center.

The Mode of Dorsal Scale Reduction as a Taxonomic Character in Snakes. Herndon G. Dowling, University of Arkansas.

Laboratory Breeding in Spadefoots (Genus *Scaphiopus*). Aaron O. Wasserman, City College.

Remarks on the Early Evolution of the Sirenidae. Coleman J. Goin and Walter Auffenberg, University of Florida.

With BOYD WALKER presiding, those attending the Ichthyological Section heard the following reports:

The Introduction and Establishment of Fish Populations in the Salton Sea, California. Boyd W. Walker, University of California, Los Angeles.

The Identity of the Bramid Species, *Taractes asper* Lowe. Giles W. Mead, United States National Museum

Carotenoids and Reproduction in Fishes. Clark Hubbs, University of Texas.

Zoogeography of the Fishes Comprising the Subtribe Labrisomini. Victor G. Springer, University of Texas.

The Buffer 'Sigma 7' and its Application to the Transport of Fishes. William McFarland and Kenneth S. Norris, University of California, Los Angeles and Marineland of the Pacific.

Temporal and Spatial Patterns of Distribution in Fishes of the Lower Mackenzie Basin. Vladimir Walters, American Museum of Natural History.

Tropical Research in Ichthyology and Herpetology. Robert R. Harry, George Vanderbilt Foundation.

After lunch, there was a joint meeting with GEORGE S. MYERS presiding. The following papers were presented:

Morphological Criteria and Their Use in Showing Bufonid Phylogeny. Richard J. Baldauf, Agricultural and Mechanical College of Texas.

Mating Call as a Possible Isolation Mechanism in the United States Hylid Frogs. W. Frank Blair, University of Texas.

Induced Spawning in Channel Catfish. Carl D. Riggs, University of Oklahoma.

The Cave Salamanders: Their Natural History and Physiology. James Kezer, University of Oregon.

Ichthyology and Industry: A New Approach. Luis R. Rivas, Ichthyological Research and Development Corporation, Coral Gables, Florida.

Vertebral Characters and the Status of *Diaphorolepis*. Charles M. Bogert, American Museum of Natural History.

The delegates then left for Audubon Park where they were lavishly feted with cocktails, seafood and all the usual (and many unusual) trimmings.

EVENTS OF SATURDAY, APRIL 20

At 9:00 a.m., the Herpetological Section began with W. F. BLAIR presiding. The following papers were presented:

The Maternal Behavior Exhibited by the Female *Eumeces obsoletus* Toward Her Eggs and Newly Hatched Offspring. Llewellyn Thomas Evans, Yeshiva University.

An Inquiline Lizard (*Eumeces egregius onocrepis*) and its Beetle Host. Wilfred T. Neill, Ross Allen Reptile Institute.

Where do the Mountains Begin? Richard M. Johnson, Tennessee Wesleyan College.

Hibernation, Hibernacula and Associated Behavior of the Three-toed Box Turtle (*Terrapene carolina triunguis*). Charles C. Carpenter, University of Oklahoma.

Feeding in the Egg-eating Snake, *Dasypeltis*. Robert Snedigar and George B. Rabb, Chicago Zoological Society.

A Modified Technique for the Preparation of Turtle Shells. James A. MacMahon, Dayton Museum of Natural History.

Some Remarks on Acrodont Amphisbaenids. Carl Gans, Harvard University.

Growth Rate of *Rana p. pretiosa* in Yellowstone Park, Wyoming. Frederick B. Turner, Wayne State University.

Mode of Reproduction and Sexual Dimorphism in Snakes. Joseph R. Bailey, Duke University.

Distribution Patterns in the Lizard Genus *Holbrookia*, and their Application to the Study of North American Zoogeography. Ralph W. Axtell, University of Texas.

Concurrently, there was an Aquarium Symposium with the following program:

1. COLLECTING.

Collecting Techniques: Caribbean. W. B. Gray of Miami Seaquarium.

Collecting Techniques: Pacific Coast. Kenneth S. Norris, Marineland of the Pacific.

2. FOOD AND FEEDING

Food and Feeding Problems: Marine and Freshwater Fishes. Lawrence Curtis, Fort Worth Zoo and Aquarium.

3. DISPLAY

A Hypothetical Approach to Planning a Trout Stream Aquarium and a Lake Aquarium, Incorporating a Biotic Community Concept. Leonard Pampel, Washington Park Zoological Gardens, Milwaukee.

Plants in the Marine Aquarium. Craig Phillips, Miami Seaquarium.

Special Exhibits and Exhibition Techniques. Earl S. Herald, Steinhart Aquarium, California Academy of Sciences.

4. SPECIAL REPORTS

The Vancouver Public Aquarium. Murray A. Newman, Vancouver Public Aquarium Association.

The Oceanarium as a Research Facility. Kenneth S. Norris, Marineland of the Pacific.

After lunch the Annual Business Meeting of the Society was called to order by VICE-PRESIDENT WOODS. The first item was a report on the Board of Governors' meeting by the Secretary. DR. GROBMAN prefaced his remarks with some statistics. As of February, 1957, the Society was distributing 1453 copies of *Copeia*. 926 went to domestic members, 256 to domestic libraries, and 235 to foreign members and libraries. At the present annual meeting there were 174 registrants and there were 40 governors present at the Board meeting.

The Secretary then gave a resume of the Board of Governors' meeting. As part of this report, DR. GROBMAN explained that an amendment to the Constitution requires a two-thirds affirmative vote of the Board of Governors and a two-thirds affirmative vote of members present at an annual Business Meeting before it is adopted. He then described the two proposed amendments (one regarding editorial machinery and the other, the Executive Committee) that had been adopted by the governors. Representing the governors, the Secretary moved their adoption. They were both duly seconded and passed: one with one dissenting vote and the other unanimously.

At this point, PRESIDENT TAYLOR assumed the chairmanship of the meeting.

The Secretary continued with his report of the Governors' meeting and stressed the formula, based on a study of 6 years of operation, that was adopted at the San Francisco meeting. It is a procedure for budgeting Society finances. The essential features are that the income for any given year is used as a base for computing available expense monies for the following year. Thus 76% of income received in 1956 is available for publishing *Copiea* in 1957, and is the annual budget for the Editor-in-Chief. This procedure provides a method for keeping the Society budget balanced as it forces expense to be related to proven income. Any surplus that may accrue, because of efficiencies in administration or the failure of the Editor-in-Chief to use his total budget, the Secretary recommended, be transferred to the Endowment Fund. Interest from the Endowment Fund, of course, becomes part of succeeding annual income.

The Treasurer's report was called for. DR. GOIN added some details that were not included in his prepared report as given to the Board of Governors. He noted that the holdings in the Society checking account at the close of business in 1956 were almost $2000 greater than the same time in 1955. He attributed this in part to the increase in dues and stated that, in his opinion, the Society was in good financial shape.

The Endowment Fund, as of December 31, 1957, had $7,000 in government bonds and $1,999.71 in a savings account.

The President then called on the Secretary for a report of a meeting of the Executive Committee. DR. GROBMAN explained that the Committee met yesterday to consider some items overlooked by the Board of Governors. Actually, he pointed out, the Committee met prematurely while anticipating its

formal birth at the present Business Meeting. DR. GROBMAN said that the Executive Committee considered meeting places for 1958 and wished to suggest to the membership either Cornell University, probably in June, or Indiana University, with the AIBS in late August. During discussion, MR. BOGERT suggested that Tucson also be considered. After considerable attention had been given the matter, the President referred it back to the same Committee.

DR. GROBMAN continued his report of the Executive Committee meeting. The Committee gave the Treasurer authority to transfer some surplus funds from the checking acount into the Endowment Fund. The Committee considered a letter from DR. KLAUBER and, as a result, the President is to ask MARGARET STOREY to continue her work and serve as a member of a committee for the ASIH to determine what can be done to obtain glass containers in sufficient quantities to satisfy the needs of members of the Society. She is to be urged to place large collective orders, if necessary.

Another item discussed briefly was the desirability of a code of ethics for herpetologists and ichthyologists. It was decided to ask DR. KARL LAGLER to report next year on the need for such a code.

The final item of the Executive Committee meeting was a report by DR. GOIN on some of the details involved in the transfer of the Treasurer's Office.

The President then called upon the Fred Stoye Prize Committee, consisting of DR. MYERS, DR. NETTING and MR. WOODS, to give its report. DR. MYERS announced the following prizes for the best student papers at the meeting. In herpetology:

First Prize, Ralph W. Axtell, University of Texas, $25.

Second Prize, John M. Legler, University of Kansas, $15.

Special Prize, James A. MacMahon, Dayton Museum of Natural History, $10.

In ichthyology:

First Prize, Victor G. Springer, University of Texas, $25.

Second Prize, Richard Rosenblatt, University of California at Los Angeles, $15.

The President then called for the report of the Committee on Herpetological Common Names. MR. CONANT gave the following report:

"After the list of common names recommended by this Committee had been published in *Copeia* the Committee succeeded in raising $250 for the publication of a special reprint. This was prepared primarily for the use of lay naturalists or for zoologists whose chief interest is not in herpetology. The reprint is divided into two sections: The first part reproduces the list exactly as it appeared in *Copeia*, and the second part is devoted to an index in which the common names appear first. Money for the reprint was contributed by E. Ross ALLEN, Carnegie Museum, Chicago Zoological Society, Friends of the Cleveland Zoo, Fort Worth Zoo and Aquarium, Lincoln Park Zoological Gardens, Chicago, New York Zoological Society, St. Louis Zoological Park, Zoological Society of Philadelphia, and Zoological Society of San Diego.

"Copies are available at one dollar each, all of which sum goes to the treasury of the American Society of Ichthyologists and Herpetologists. Sales to date have been brisk, and with some help from other members your Chairman has already collected sixty dollars. Copies are obtainable from him or from DR. N. BAYARD GREEN, Publications Secretary of the Society. Incidentally, copies are for sale right here. The Committee suggests that you encourage your students, associates, and especially amateur herpetologists to purchase copies. They will find them useful, and they will be helping the Society financially.

"Several copies of the special reprint were sent to each donor, and a copy was also mailed to each curator of reptiles or director of a Zoo maintaining a reptile exhibit, and also to a large number of museums. A letter from the Committee was mailed with the lists urging cooperation in the effort to work toward standardization of common names. Several suggestions were offered, among them being first 'as labels become worn or damaged replace them with new labels using the names listed in the Committee's report.' Information is now at hand indicating that re-labeling has been started in the herpetological departments of the New York (Bronx) Zoo, Philadelphia Zoo, San Diego Zoo, Baltimore Zoo, Washington Zoo, Carnegie Museum, Newark Museum, and the Buffalo Museum of Science. A similar change is planned for the reptile exhibit hall at the American Museum of Natural History.

"Suggestion number two read as follows: 'If you issue a new guide book or refer to reptiles and amphibians in your magazine or any pamphlets, use the new names.' The following publications, either in preparation or planned for the near future, will use the names listed by the Committee:

Check List of North American Amphibians and Reptiles, 7th ed., by Karl P. Schmidt

Manual of North American Vertebrates (Reptile section), by Fred R. Cagle

A Field Guide to the Reptiles and Amphibians, by Roger Conant

Handbook of Herpetology, by Coleman J. Goin

Reptiles of the World, by Karl P. Schmidt and Robert F. Inger

The Reptile World (an edition for children), by Clifford H. Pope

Revision of Amphibians and Reptiles of Western North America, by Robert C. Stebbins

Herpetological articles in *Copeia* will also use the names.

"The Committee's third and final suggestion was worded as follows: 'Encourage your associates or students to use the new names. If you have a nature or herpetological club that meets at your institution, build a program around the Committee's pamphlet. Encourage youngsters to acquire copies of the pamphlet.' Several of the recipients have indicated their intention of following one or more of these suggestions.

"It is hoped that the sale of the special reprints will not only yield enough money to reimburse the Society for its investment in publishing the list in *Copeia*, but that it will also supply some additional revenue."

Under New Business, several informational items were mentioned. DR. RIGGS described a new organization, the Southwestern Association of Naturalists, that has recently begun a journal, the *Southwestern Naturalist*.

MR. BOGERT advised herpetological members to forward publications, intended for mention in the *Zoological Record*, to Miss Grandison at the British Museum.

MR. BALDAUF suggested the desirability of having the *Zoological Record* entries on IBM cards. During the discussion that followed, Dr. Cagle spoke about the Publications Committee of the AIBS which has a special subcommittee concerned with the retrieval of biological information.

PRESIDENT TAYLOR then called for a report from the nominating committee which consisted of MR. BOGERT, DR. W. B. SCOTT, DR. PETERS, DR. LACHNER, DR. CAGLE, and DR. CARL HUBBS, Chairman.

MR. BOGERT gave the report for the Committee and prefaced his remarks with the statement that the President is elected for a two year term and, therefore, the next presidential election will be at the 1958 meeting. He also pointed out that the terms of officers elected at this meeting are to begin on January 1, 1958. The following persons were nominated and duly elected to the offices indicated below:

Vice-President for Conservation: Boyd Walker
Vice-President for Finance: John Marr
Vice-President for Membership: James Kezer
Secretary: Roger Conant
Treasurer: James Böhlke
Publications Secretary: N. Bayard Green
Editor-in-Chief: Fred R. Cagle
Editorial Board
  Book Review Editor: Ernest Williams
  Index Editor: David Jameson
Ichthyological Board:
  John C. Marr
  Robert R. Miller
  Edward C. Raney
  Rolf L. Bolin
  Reeve M. Bailey
  Edward M. Nelson
  Carl L. Hubbs
  Robert W. Harrington, Jr.
  Ernest A. Lachner
  David Dunkle
Herpetological Board:
  D. Dwight Davis
  Norman Hartweg
  L. M. Klauber
  James A. Oliver
  Karl P. Schmidt
  Robert C. Stebbins
  Wade Fox, Jr.
  Charles E. Shaw
  Clifford H. Pope
  Edwin H. Colbert

Discussion then was centered about the length of the initial term of office for the new Editorial Board which, in part, replaces the divisional editors. Since DR. GOSLINE had previously resigned as Ichthological Editor and since it was understood that DR. STEBBINS was agreeable to continue as Herpetological Editor or to participate as a member of the new Board, it seemed desirable for the new Board to take office immediately. DR. NETTING moved that the initial term of the new Editorial Board commence at once and continue until December 31, 1958. The motion was duly seconded and carried.

DR. MYERS then spoke briefly about JACK NICHOLS, the founder of the Society. He suggests that an early issue of *Copeia* be devoted to DR. NICHOLS. The Secretary pointed out that the By-Laws cover the procedure for selecting anniversary and memorial numbers in very explicit terms. DR. NETTING, supporting DR. MYERS' suggestion, proposed that such a number be referred to in some other fashion than "anniversary" or "memorial." DR. GOIN then moved that the Executive Committee and DR. MYERS investigate the proposal and, if they find it desirable, that they implement it. The motion was seconded and passed.

In answer to queries, DR. CAGLE explained some of the problems facing *Copeia*. The reason 1957 numbers were coming out late, he explained, was because Waverly Press changed to a 37½ hour work week and it is about 45 days late in its printing schedule. He also discussed briefly some budgetary problems and gave some statistics comparing *Copeia* with some other biological journals.

PRESIDENT TAYLOR then called upon the retiring Secretary. DR. GROBMAN expressed his thanks to

the great many members of the Society who had been helpful to him in conducting the affairs of the ASIH and said that he hoped MR. CONANT would enjoy the same kind of co-operation.

PRESIDENT TAYLOR closed the business meeting with the remark that he had attended a great many meetings of the ASIH and he was absolutely convinced that there has never been a session in which there had been more entertaining and instructive papers. He had never been at a meeting where the sessions were better attended and he considered this a great compliment to our Society.

The meeting adjourned at 4:00 p.m.

The annual banquet began in the Jung Hotel at 7:00 p.m. After an excellent dinner, TOASTMASTER BOGERT introduced guests. MISS GRANDISON, of the British Museum, gave a delightful talk telling of her apprehensions about collecting in America in the company of domestic herpetologists. DR. VANZOLINI, of Brazil, chose a remarkably similar topic telling about the adventures of a Brazilian explorer on a safari in Cambridge, Massachusetts, and the effectiveness of the native baggage carriers. DR. SCHMIDT and MR. VIOSCA reminisced about some of their interesting herpetological experiences over the years. DR. PARR and DR. CAGLE spoke briefly. DR. GROBMAN and DR. GOIN received a round of applause for their six years of service as Secretary and Treasurer of the Society.

The Resolutions Committee report was read by MR. POPE as follows:

"Whereas the 37th Annual Meeting of the American Society of Ichthyologists and Herpetologists is being successfully concluded, and, whereas the orderly and efficient conduct of the meeting and the several pleasurable social and field events have been due to the careful planning and energetic efforts of the local committee composed of CHAIRMAN FRED R. CAGLE and

Royal D. Suttkus	George Douglas
E. Peter Volpe	Norman Negus
George Penn	Joseph Young
Kenneth Hutton	Percy Viosca, Jr.
John De Abate	Mrs. E. Williamson
Don Boyer	Mrs. N. Clements
Rudolph Miller	Miss S. Harvey
James Dobie	Miss S. Whitsell
Robert Feuer	Robert Chipman
Mrs. Royal Suttkus	Mrs. Fred R. Cagle
Mrs. Norman Negus	Mrs. Peter Volpe
George P. Meade	Mrs. George Penn
Gordon Gunter	Mrs. Joseph Young
Austin Fitzjarrell	Ned Simmons
	E. S. Hathaway

"Be it, therefore, resolved that the ASIH express deep appreciation and high commendation to each and every one of these.

"Whereas the Audubon Park Zoo, represented by MR. GEORGE DOUGLAS, provided delightful southern hospitality in the form of cocktails, dinner, and entertainment on the evening of the third day of this meeting, be it therefore resolved that the ASIH express its appreciative thanks to MR. DOUGLAS and his committee, composed of

Mrs. George Douglas
Mrs. and Mrs. Robert Paterson
Mrs. Robert Bradley
Mr. Justin Douglas
Mr. and Mrs. William Pohlman
Dr. and Mrs. Lynn Hughes
Mr. and Mrs. J. Le Blanc

and last, but by no means least, Mr. J. William Fruchtnicht, who prepared the delicious food.

"Whereas, DR. and MRS. FRED R. CAGLE graciously entertained the members of the Board of Governors with delicious food and stimulating drinks at their attractive home and garden the evening before the sessions,

"Be it, therefore, resolved that the ASIH express its thanks to DR. and MRS. FRED R. CAGLE for so thoughtfully entertaining the Society's officers.

"Whereas, two of our officers, now retiring, SECRETARY ARNOLD B. GROBMAN and TREASURER COLEMAN J. GOIN, have served with great loyalty and efficiency over a protracted term of six years; and

"Whereas, it is fully realized that such service requires much time and personal sacrifice,

"Be it, therefore, resolved that the ASIH express its deep gratitude and appreciation to ARNOLD B. GROBMAN and COLEMAN J. GOIN."

The major address of the evening was by DR. GEORGE MYERS and was entitled "Natural History of American Ichthyologists and Herpetologists." DR. MYERS spoke of the many interesting and illustrious zoologists he had met during his long and varied career.

EVENTS OF SUNDAY, APRIL 21

There were a number of interesting field trips to areas in the vicinity of New Orleans.

During the meetings, a group photograph was taken and another number of *Dopeia* was distributed. The latter may be obtained from the Publication's Secretary for $0.25.—ARNOLD B. GROBMAN, RETIRING SECRETARY

BOARD OF GOVERNORS

1958

Class of 1958: J. W. Atz, W. L. Follett, R. R. Harry, G. L. Orton, J. A. Peters, B. Schaeffer, L. P. Schultz, W. H. Stickel, R. D. Suttkus, J. Tee-Van.

Class of 1959: R. H. Bachus, A. P. Blair, H. G.

Dowling, H. W. Freeman, H. K. Gloyd, J. D. Kilby, K. F. Lagler, J. M. Savage, E. H. Taylor, R. W. Yerger.

Class of 1960: F. N. Clark, G. P. Cooper, N. Hartweg, J. Kezer, G. A. Moore, R. C. Snyder, M. Storey, B. Walker, C. Walker, N. Wilimovsky.

Class of 1961: J. R. Bailey, W. F. Blair, J. Böhlke, J. C. Briggs, R. Conant, H. Fitch, E. S. Herald, W. J. Riemer, M. Trautman, V. Vladykov.

Class of 1962: E. Clark, W. Clay, C. J. Goin, A. B. Grobman, R. W. Harrington, C. F. Hubbs, R. Inger, N. Richmond, R. Robins, R. Zweifel.

Past Presidents: C. M. Bogert, C. M. Breder, J. R. Dymond, H. W. Fowler, H. T. Gaige, W. K. Gregory, C. L. Hubbs, L. M. Klauber, G. S. Myers, M. G. Netting, J. T. Nichols, C. H. Pope, E. C. Raney, A. G. Ruthven, K. P. Schmidt.

Ex Officio Members

National Officers:

R. M. Bailey, J. Böhlke, R. Bolin, F. R. Cagle, E. H. Colbert, R. Conant, D. D. Davis, D. Dunkle, W. Fox, N. B. Green, R. W. Harrington, N. Hartweg, D. Jameson, J. Kezer, E. Lachner, J. Marr, R. Miller, E. M. Nelson, J. A. Oliver, C. E. Shaw, R. C. Stebbins, E. H. Taylor, B. Walker, E. Williams.

Divisional Officers:

J. R. Bailey, E. E. Brown, F. N. Clark, L. Dempster, W. J. Riemer, A. M. Woodbury.

Working Version of the Constitution and By-laws of the American Society of Ichthyologists and Herpetologists

Adopted June 29, 1951

(With Amendments through April 20, 1957)

Prefatory Note:—During my term of office as Secretary, the Constitution and By-laws had been amended at least 14 times. Thus the last published version of our organic law (Copeia, 1952 (1): 54–57) has been changed considerably. A person intending to use the Constitution and By-laws would find it necessary to peruse the minutes of the annual meetings subsequent to 1952. Taking advantage of my recent experience, I have incorporated these changes into their proper places in the document in order to save others the necessity of such delving. While doing so, I found some inconsistencies in wording between the original regulations and the proposed changes. In one instance, I reorganized a by-law to express what I believe to be the sense of the amendment. For these reasons, the following draft can only be considered an unofficial working version of the Constitution and By-laws. For those who require technical preciseness in such matters, reference must be made to the Constitution, as cited above, and the subsequent minutes of the annual meetings.—Arnold B. Grobman, Retiring Secretary.

Constitution

Article I: Name

The name of this Society shall be "The American Society of Ichthyologists and Herpetologists." The Society is incorporated in the District of Columbia (November 22, 1949).

Article II: Object

The object of this Society shall be to advance the science of the study of fishes, amphibians and reptiles.

Article III: Membership

Section 1. Members shall be chosen from among persons interested in the object of the Society.

Section 2. The membership of the Society shall consist of the following classes:

a. Active Members who pay annual dues in the following categories: Student, Foreign, Regular, Subscriber, and Sustaining.

b. Active Members who make a single payment in the following categories: Life and Patron.

c. Honorary Foreign Members shall be chosen from among the ichthyologists and herpetologists, located outside of the United States, who have attained distinction as investigators. The Honorary Foreign Members shall be equally divided between ichthyologists and herpetologists.

Section 3. Nomination to membership shall be upon the recommendation of one member.

Article IV: Officers

Section 1. The officers of the Society shall be: Honorary Presidents John Treadwell Nichols (ichthyology) and Helen T. Gaige (herpetology) for life. A President, elected for a two-year term, eligible for a second term only after a lapse of two or more years, office to alternate between an ichthyologist and a herpetologist; three Vice-Presidents elected for a one-year term but eligible for immediate re-election; a Treasurer, a Secretary, and a Publications Secretary, all of whom may be re-elected annually but who may serve unlimited consecutive terms; an Editor-in-chief and an editorial board of twenty-two, of whom one shall be a book review editor, one an index editor, ten shall be ichthyologists, and ten shall be herpetologists, each of whom shall be elected annually but who may serve unlimited consecutive terms.

Section 2. The officers shall be elected at the annual business meeting from among active members in good standing. The slate of nominees shall

be furnished by a nominating committee of five members to be appointed by the President at or shortly after the time of the previous annual meeting. The term of office shall commence on January 1, following the annual meeting at which the officers were elected.

Section 3. The officers named in Section 1 shall discharge the duties usually assigned to their respective offices (see by-laws).

Section 4. The business of the Society shall be conducted by a Board of Governors. The Board shall consist of not more than 50 elective members, each elected for a term of 5 years. Elective members of the Board whose terms have expired at the time of the annual meeting shall not be eligible for re-election to the Board until the time of the next annual meeting. The incumbent officers of the Society, including those of each recognized division, shall be ex-officio members of the Board. Former Presidents of the Society shall be members of the Board for life.

Section 5. Vacancies in the membership of the Board of Governors shall be filled by the Board of Governors at the time of the annual meeting.

Section 6. A vacancy in either the Secretaryship or Treasurership occurring in the interval of the meetings of the Society may be filled, until the next annual meeting, by appointment by the President.

Section 7. The Executive Committee shall consist of the President, Vice-Presidents, Secretary, Treasurer and Editor-in-chief.

Article V: Meeting of the Society

Section 1. This Society shall hold an annual meeting.

Section 2. The place of the annual meeting of the Society shall be determined by the Board of Governors. Notice of the meeting shall be mailed to all members of the Society at least three weeks before the date set for the meeting.

Article VI: Western Division

Section 1. The Western Division of the Society shall consist of those members from Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, Hawaii, Alaska, Alberta and British Columbia.

Section 2. The Western Division shall elect its own Officers, President, Vice-President, and Secretary-Treasurer, and hold annual meetings.

Article VII: Southeastern Division

Section 1. The Southeastern Division shall consist of those members from Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and the District of Columbia.

Section 2. The Southeastern Division shall elect its own officers, President, Vice-President, and Secretary-Treasurer, and hold annual meetings.

Article VIII: Quorum

Twenty-five members shall constitute a quorum of the Society and ten a quorum of the Board of Governors.

Article IX: Changes in the Constitution

Section 1. Amendments to this Constitution may be adopted at any meeting of the Society if approved by two-thirds of the members of the Board of Governors voting and two-thirds of the members voting at the annual business meeting.

BY-LAWS

Article I: Dues

Section 1. Annual dues shall be payable January 1, in advance. *Copeia* shall not be sent to those in arrears for dues. Upon payment of arrearage, the former member shall be reinstated.

Section 2. Life members may pay their dues in one lump sum or in annual installments of $25 each. All sums paid by Life Members shall be kept in a separate account, the Endowment Fund, during the lifetime of the Member.

Section 3. A service charge of $1.00 may be billed subscribers requiring special billing procedures.

Section 4. The following is the schedule for dues and subscriptions:
Foreign and student members: $6.00 annually
Regular members: $8.00 annually
Subscribers (institutional): $9.00 annually
Sustaining members: $25.00 annually
Life members: $150.00 single payment
Patrons: $1000.00 single payment

Article II: President and Vice-Presidents

Section 1. The President shall preside at sessions of the Board of Governors and at the business meeting.

Section 2. The President shall also appoint the committees prescribed by the constitution and by-laws.

Section 3. The Vice-Presidents shall preside at sessions designated by the President, and, in order, shall assume the duties of the President in the latter's absence.

Section 4. The Vice-Presidents shall have added responsibilities as follows: a. The First Vice-President shall have charge of all conservation matters and shall serve as Chairman of the Conservation

Committee. b. The Second Vice-President is designated as Finance Vice-President and shall act as Chairman of a finance committee of five members, including the Secretary and Treasurer. This committee will have the duty of advising and directing the treasurer and other officers in the management and investment of all funds and monies of the Society. c. The Third Vice-President shall be expected to devote his attention to the obtaining of new members, in all classifications, and shall be Chairman of the Membership Committee.

Article III. Secretary

Section 1. The Secretary shall keep the records of the Society and report at the annual meeting.

Section 2. He shall be responsible for sending out notices announcing the annual meeting and for arranging the agenda for the Board of Governors and business meeting at the annual meeting.

Section 3. He shall be reimbursed out of the monies of the Society for expenses incurred in attending meetings of the Society.

Section 4. He shall make such purchases and employ such assistance as is necessary to conduct the business of the Society within limits to be set annually by the Board of Governors.

Section 5. Unless other arrangements are made at the annual meeting he shall act as delegate or representative of this Society at meetings of related societies covering matters of mutual interest.

Article IV: Treasurer

Section 1. The Treasurer shall be in charge of the funds and securities of the Society.

Section 2. At the annual business meeting of the Society he shall present a statement of the funds and monies of the Society, the statement to cover the calendar year.

Section 3. The President shall annually appoint an auditing committee of two, who shall audit and report upon the financial record and statement of the Treasurer at the annual business meeting.

Article V: Publications Secretary

Section 1. The Publications Secretary shall be charged with the responsibility for the safe storage and sale of back numbers of *Copeia*.

Section 2. He may employ such assistance as is necessary upon approval of the Secretary and Treasurer.

Section 3. He shall prepare a report covering the back number business for presentation to the Society at its annual meeting.

Article VI: Publications Committee

Section 1. The Editors, Editorial Board, President, Secretary, Publications Secretary and Treasurer shall constitute the Publications Committee of the Society.

Section 2. Matters pertaining to publication costs and similar matters shall be the responsibility of this committee.

Article VII: Meetings

Section 1. The chairman of the local committee shall be appointed by the President, if possible at least 6 months before the time of the meeting.

Section 2. The chairman of the local committee shall be responsible for all local arrangements, including the arrangements for printing the program.

Article VIII: Funds

Section 1. The Frederick H. Stoye Fund shall remain invested (in bonds) until maturity and then be reinvested with the principal left intact. The income is to be used to offer awards for meritorious papers presented by student members at the annual (National) meeting. After the demise of Mr. Stoye the principal of the fund is to remain invested as now and the income used to provide student awards at all the meetings or to be used in any manner that the officers of the Society may decide. The prizes awarded at the meetings are to be known as the Frederick H. Stoye Awards.

Section 2. The Revolving Research Fund is available for small grants to younger members for assistance in research. There is no obligation to repay these grants, although it is expected that recipients will contribute a like or greater sum to the fund when professionally established and able to do so.

Section 3. The Endowment Fund shall consist of donations and payments received from Life Members. Only the income from the Life Membership payments may be used by the Society during the lifetime of the member. Upon death of a life member the principal may be transferred to the current account of the Society.

Article IX: Gifts and Bequests

Section 1. Gifts, donations, and bequests may be given directly to the Society.

Section 2. Unless some special purpose accompanies such gift, donation, or bequest, the Board of Governors of the Society may disburse the principal or income for the object of the Society as specified in the Constitution under Article II.

Article X: Anniversary and Memorial Numbers of Copeia

Nominations pertaining to Anniversary and Memorial numbers shall be submitted in writing to the President at least three months in advance of

the annual meeting. Such nominations shall be studied by a committee consisting of the officers of the Society, and if approved by this committee, the nominations shall be submitted to the Board of Governors at the annual meeting for its action. If the committee is not in favor of the nomination, the Secretary shall so inform the person making the original proposal.

Article XI: Honorary Foreign Members

The number of Honorary Foreign Members shall not exceed 20.

Article XII: Society Set of Copeia

An official bound set of COPEIA shall be maintained in the office of the Editor-in-chief. A second official bound set of COPEIA shall be maintained in the office of the Secretary.

Article XIII:

Procedures and other items, not specified in the Constitution or By-Laws of this Society or by action at the annual meeting, shall be in accordance with Roberts Rules of Order.

K. P. Schmidt ON September 26, 1957, KARL PATTERSON SCHMIDT died. Twenty-four hours earlier he had been bitten by a juvenile boomslang, *Dispholidus typus*, brought to the Chicago Natural History Museum for identification from the Lincoln Park Zoo. ROBERT INGER received the snake and, together with HYMEN MARX, was examining it when DR. SCHMIDT took the snake from DR. INGER. He was immediately bitten in the distal segment of the thumb. The identity of the snake was soon discovered and DR. SCHMIDT was informed. He refused to believe that the bite of a young *Dispholidus* could be serious and the other witnesses, who knew even less about the boomslang, bowed to his judgment.

It was characteristic that, considering the dearth of information about *Dispholidus*, K. P. SCHMIDT immediately began writing his own case history. His record will appear in COPEIA at a later date.

In brief the distal joint of the thumb swelled slightly and became tender to the touch. Minor symptoms of shock, nausea and a slight chill, appeared three hours later and in two more hours had disappeared. Except for minor bleeding in the mouth, no other symptoms appeared until the next day. DR. SCHMIDT called DR. INGER to say he felt fine but would rest that day and gave the same information to the director of the museum, COL. C. C. GREGG, at mid-morning.

At 1:30 p. m., almost exactly twenty-four hours after being bitten, he suddenly collapsed. For the first time a doctor was called in, but it was too late. As of the time this notice is written, the exact cause of death is not known. Unfortunately everyone failed to regard the bite as serious. Whether the outcome could have been otherwise is impossible to say. As it is, the society has lost its outstanding and best-loved member.

It should give his colleagues some small satisfaction that in August, K. P. SCHMIDT was cited as Eminent Ecologist by the Ecological Society of America. A memorial issue of COPEIA is planned to honor this golden character.

Viktor Pietschmann DR. VIKTOR PIETSCHMANN died November 11, 1956, soon after his seventy-fifth birthday. DR. PIETSCHMANN was long Curator of Fishes in the Natural History Museum in Vienna in which position he followed FRANZ STEINDACHNER. He worked at the Bishop Museum in Honolulu in 1927–28, and published extensively on fishes of the central Pacific, on Polar regions and elsewhere.

Beebe Types The collection of type specimens of fishes described principally by DR. WILLIAM BEEBE, Director of the Department of Tropical Research of the New York Zoological Society, and his staff has been donated to the United States National Museum and to Stanford University. The division of this collection was made on a geographical basis. The types of species described from Atlantic Ocean localities are now in the National Museum, those from the Pacific in the Natural History Museum, Stanford University. A detailed list of the type specimens of fishes resulting from DR. BEEBE'S work and their present location is in preparation.

Zoological Nomenclature Notice is given that the possible use by the International Commission on Zoological Nomenclature of its Plenary Powers is involved in applications relating to the undermentioned name included in Part 9 of Volume 13 of the *Bulletin of Zoological Nomenclature* published on 30th September, 1957:

Phrynosoma Wiegman, 1828, validation of (Class Reptilia, Order Squamata) (Z. N. (S) 399.).

Any specialist who may desire to comment on the foregoing application is invited to do so in writing to the Secretary to the International Commission (Address: 28 Park Village East, Regent's Park, London N.W. 1, England,) as soon as possible. Every such comment should be clearly marked with the Commission's File Number (A (n. s.) 39) and sent in duplicate.

If received in sufficient time before the commencement by the International Commission of voting on the application in question, comments

received in response to the present Notice will be published in the *Bulletin of Zoological Nomenclature*: comments received too late to be so published will be brought to the attention of the International Commission at the time of the commencement of voting on the application in question.

News Notes

PROFESSOR J. A. ROZE of the School of Science, Central University, Caracas, and BROTHER GINES, Director of the LaSalle Society of Natural Sciences, Caracas, have received Creole Foundation awards permitting them to study amphibian and reptile collections in museums of the United States over a three-month period. The Creole Foundation, organized in 1956 by the Creole Petroleum Corporation, was established to support and encourage educational, cultural and scientific activities. While the primary focus of the Foundation is on the Venezuelan community, some of its programs involve related activities abroad, particularly in the United States.

DR. MAURICE BLACKBURN, well known for his research on the fishes and fisheries of Australia, has resigned his position at the University of Hawaii to take charge of an investigation of the availability of tuna under a Saltonstall-Kennedy project based at the University of California, La Jolla.

DR. DAVID H. DAVIES, formerly in charge of fisheries research in South Africa, has joined the staff of the University of California, La Jolla, to investigate the relationships between kelp and fishes, on a kelp research project being conducted for the California Fish and Game Commission.

DR. ROLF L. BOLIN is spending the academic year of 1957–58 as a Fulbright researcher at the University of Hong Kong initiating work on a planned guide book to the fishes of the area. Subsequently he will spend shorter periods examining myctophids at the Australian Museum and at several institutions in Japan.

Colloquium on Zoological Nomenclature

IT IS HOPED that the Fifteenth International Congress of Zoology (London, July, 1958) will approve and adopt the new text of the International Code for Zoological Nomenclature as revised by the preceding Congresses held in Paris in 1948 and Copenhagen in 1953. A draft of the revised text will be submitted for this purpose to the London Congress. Arrangements have been made between the Secretariat-General of the Congress and the International Trust for Zoological Nomenclature under which a Colloquium on Zoological Nomenclature is being organized by the International Trust.

The Colloquium will open on Wednesday, July 9, one week prior to the opening of the London Congress. It is hoped that this body will be able to relieve the Congress of the bulk of the work involved in the scrutiny of the draft of the revised Code and will submit to the Congress agreed recommendations as to the text to be adopted. Invitations to the Colloquium have been issued by the Trust to a large number of zoologists. In addition, arrangements have been made between the Trust and the Secretariat-General of the Congress under which an invitation to the Colloquium will be issued by the Trust to any member of the Congress who expresses a desire to take part in its discussions but who has not as yet received a separate invitation.

INDEX TO SCIENTIFIC NAMES
1957 Nos. 1–4

New names and their principal references are printed in bold face type

Abastor, 141
Abastor erythrogrammus, 141
Abronia, 94
acanthias, Oneirodes, 238
Acanthophis, 265
  antarcticus, 231, 265
Acartia, 183
Achalinus, 260
Achirus
  fluviatilis, 13, 15
  mazatlanus, 13
  panamensis, 14
Acinacea, 322
  notha, 322
Acris, 31–35
  crepitans, 38, 88, 141
  gryllus crepitans, 31–36, 46
  gryllus dorsalis, 275
  gryllus gryllus, 46
Acrochordus, 258, 260
Adelphicos, 93
adocetus, Cololabis, 57
Aeluroscalabates, 30
aeneus, Aneides, 98
aeneus, Desmognathus aeneus, 44
aepyptera, Lampetra, 54
Aetobatus narinari, 156
affine, Myctophum, 317
affinis, Elops, 15
affinis, Gambusia, 299
affinis, Nothopsis, 211, 255–256, 259
Agalychnis, 91–92
  moreleti, 94
agassizi, Gopherus, 301
Agkistrodon, 167, 323
  contortrix laticinctus, 50, 310
  contortrix mokeson, 50
  piscivorus, 47, 266

Agonostomus, 173
Agonus decagonus, 20
Aigialosaurus, 25
Akeptosaurus, 70
alalunga, Germo, 239
alalunga, Thunnus, 242–243
albacares, Thunnus, 242
albigularis, Gerrhonotus, 26
albiguttus, Paralichthys, 14
Albula vulpes, 156, 248
albus, Cynoscion, 15
Alectis crinitus, 243
Alepisaurus ferox, 298–299
aleuticus, Cottus, 157
alleganiensis, Cryptobranchus alleganiensis, 43, 46
alleteratus, Euthynnus, 157
Alligator, 30
Allocyttus verrucosus, 244–245
Alosa sapidissima, 252
Alphestes, 285–286
  galapagensis, 285
  multiguttatus, 285
  scholanderi, 283–286
alpinus, Salvelinus, 17
Alsophis angulifer, 49–50
altavela, Gymnura, 156
altus, Pseudopriacanthus, 156, 241
alvarezi, Gambusia, 299–300
alvarezi, Heloderma horridum, 63
alvarius, Bufo, 143
Alytes obstetricans, 65
Amastridium, 260
amaura, Lampropeltis doliata, 50, 310
Amblyopsis, 131
Ambystoma 46, 65, 108–109
  annulatum, 108–109
  cingulatum, 43, 109
  gracile, 109
  jeffersonianum, 141–142
  mabeei, 43, 109
  macrodactylum, 109, 308
  maculatum, 98, 142
  opacum, 109
  talpoideum, 109
  texanum, 47, 109, 280
  tigrinum, 43, 109
  tigrinum melanostictum, 308
  tigrinum tigrinum, 46
Ameiurus, 67
Ameiva
  festiva, 92
  undulata, 92
americana, Periplaneta, 151
americanus, Bufo, 208, 210–211
americanus, Bufo terrestris, 37, 98, 311
americanus, Esox, 67
americanus, Morone, 9
americanus, Roccus, 1–9
Ammocrypta, 67
amoenus, Carphophis amoenus, 98
Amphibamus, 69
Amphisbaena, 28
anajouanae, Melania, 66
analis, Lutianus, 243
analostanus chloristius, Notropis, 187–188, 190, 193
analostanus, Notropis, 189, 191
analostanus, Notropis analostanus, 188, 190–193
Anarhichas lupus, 240
Anchovia curta, 14
andersoni, Hyla, 31–36, 141
Aneides
  aeneus, 98
  flavipunctatus, 108
  hardyi, 108
  lugubris, 108
Anguilla, 170
anguinus, Proteus, 317
Anguis, 22, 25, 27–28
  fragilis, 23, 27
angulifer, Alsophis, 49–50
angulifer, Epicrates, 151, 50, 310
annectens, Pituophis catenifer, 50, 310
Anniella, 21–22, 24–25, 29, 150
  geronimensis, 150
  pulchra, 148, 150
  pulchra nigra, 150
  pulchra pulchra, 148, 150
annulata, Lampropeltis doliata, 50, 310
annulatum, Ambystoma, 108–109
Anolis, 92, 145, 263–264
  carolinensis carolinensis, 309
  equestris, 145
Anomalepis, 26
Anomalochilus, 30
anomalum, Campostoma, 53, 250
Anoptichthys, 123–132
  hubbsi, 123
  jordani, 129–130
antarcticus, Acanthophis, 231, 265
antillarum, Ijimaia, 234–235
Apeltes quadracus, 195
Apletodon, 205, 207
Aprasia, 28, 30
  repens, 28
Aprinodon, 294
  isodon, 293
Arapaima gigas, 54–56
arenicolor, Hyla, 309
areolata, Rana, 38–39, 47
argentiventris, Lutianus, 13
argus, Python, 25
arietans, Bitis, 266
Aristelliger, 28
Arizona, 218
armatus, Leptocottus armatus, 241–242
Ascaphus truei montanus, 308
asper, Cottus, 15
asper, Taractes, 323
Aspidophoroides olriki, 20
Aspis, 269
Astyanax, 123, 125, 128–129, 132
  mexicanus, 123, 133
Atelopus, 93
atlanticus, Liparis, 18
atlanticus, Megalops, 139–140
Atractus, 317
Atretium schistosum, 25
atricaudatus, Crotalus horridus, 310
atrilabiatus, Callionymus, 159
atromaculatus, Semotilus, 53
atrox, Bothrops, 256, 266
atrox, Crotalus, 50, 265–268, 310, 314
attenuatus, Batrachoseps, 108
auratus, Carassius, 241–242
auratus, Mullus, 243
aureolum, Moxostoma, 154–155
auriculatus, Desmognathus fuscus, 46–47
auro-taenia, Dendrobates, 78
australis, Remora, 157
Auxis thazard, 243
axelrodi, Cheirodon, 323

bairdii, Peromyscus maniculatus, 306
Barisia, 91, 93

bartramiana, Hyla crucifer, 47, 88
Basiliscus, 91
Bassariscus, 218
Bathysiredon, 78
Batrachoseps
  attenuatus, 108
  pacificus, 108
bayanus, Pomadasys, 15
beatriciae, Phyllobates, 78
Bellia, 70
belli, Chrysemys picta, 309
Belone, 184
berlandieri, Gopherus, 307
berlandieri, Rana pipiens, 37
Beryx decadactylus, 299
Beryx splendens, 298–299
bicirrhosum, Osteoglossum, 55
bicolor, Loxocemus, 50, 310
bicolor, Phyllobates, 77
bifrenatus, Notropis, 196, 318
biguttatus, Hybopsis, 250
bimaculatus, Labrus, 303
bislineata cirrigera, Eurycea, 44
bislineata, Eurycea, 98, 108
bislineata wilderae, Eurycea, 44
bispinatus, Euprotomicrus, 58
Bitis, 273
  arietans, 266
bivittatus, Python molurus, 50, 310
blandingi, Emys, 230
Boa constrictor imperator, 50, 310
boleosoma, Gobionellus, 157
Bolitoglossa, 91
bombifrons, Scaphiopus, 37–38, 145, 308
borealis, Sphyraena, 242
boreas, Bufo boreas, 308
boreas halophilus, Bufo, 146
Boreogadus saida, 10–12, 19
Bothrops, 92
  atrox, 256, 266
bottae, Charina, 51
bottae utahensis, Charina, 309
boulengeri, Phyllobates, 78
brachycephala, Rana pipiens, 309
Brachymeles gracilis taylori, 144
brachyphona, Pseudacris, 45–46
Brachyplatystoma filamentosum, 56
Brachyrhaphis, 201
  episcopi, 195, 201
bramma, Notelops, 139
breviceps, Moxostoma, 155
brevimanus, Gerres, 13
Brevoortia tyrannus, 14
brimleyorum, Desmognathus, 46
brimleyorum, Desmognathus fuscus, 46–47
bronni, Leptolepis, 139
browni, Heterodon, 312–313
brunneus, Phyllobates, 77
bubalinus, Cyprinella, 185
bubalinus, Leuciscus, 185–186
Bufo, 31, 36–37
  alvarius, 143
  americanus, 208, 210–211
  boreas boreas, 308
  boreas halophilus, 146
  cognatus, 37–39, 88
  calamita, 228
  canorus, 317
  fowleri, 211
  houstonensis, 210–211
  microscaphus, 208–212
  melanostictus, 146–147
  punctatus, 209–210
  terrestris, 210–211
  terrestris americanus, 37, 98, 311
  terrestris charlesmithi, 37, 38, 85–89
  valliceps, 211
  woodhousei, 208–212, 143
  woodhousei fowleri, 31, 98
  woodhousei microscaphus, 212
bufonius, Leptodactylus, 233
Bungarus, 260
burtoni, Lialis, 230–231

cadenati, Opeatogenys, 206
caeruleus, Etheostoma caeruleus, 250
caeruleus, Notropis, 187–190, 192–193
Cachuga, 70
caddoensis, Plethodon, 47
calamita, Bufo, 228
californiensis, Eucinostomus, 13
Callichthys littoralis, 55
calligaster, Lampropeltis calligaster, 48
callilaemus, Dromicus, 25–26
Callionymus, 159
  atrilabiatus, 159
  garthi, 159–160
Callisaurus draconoides, 148
callisema, Notropis, 187–191, 193
callitaenia, Notropis, 187–191, 193
callistius, Notropis, 187–191, 193
Callochromis, 162
  pleurospilus, 162
Calotes versicolor, 25
Campostoma anomalum, 53, 250
camurus, Notropis, 187–190, 193
canadus, Rachycentron, 243
canorus, Bufo, 317
capelli, Lophotus, 60
capensis, Quinquarius, 245
capito, Mugil, 14
capito, Rana, 215–216
capito sevosa, Rana, 47
Caranx
  crysos, 243
  hippos, 243
Carassius, 241
  auratus, 241–242
carcharias, Carcharodon, 155, 246
Carcharias taurus, 156
Caracharodon carcharias, 155, 246
Carcinides maenas, 156
cardinalis, Hyphessobrycon, 323
Caretta, 144
caretta, Testudo, 141
carinata, Cyclura, 24
carinatum, Moxostoma, 154
carolina, Terrapene carolina, 280
carolina triunguis, Terrapene, 278–279, 324
carolinensis, Anolis carolinensis, 309
carolinensis, Desmognathus ochrophaeus, 98
carolinensis olivacea, Microhyla, 37, 88
Carphophis amoenus amoenus, 98
carri, Tropidodipsas, 111
caspica, Clemmys caspica, 51
catenifer annectens, Pituophis, 50, 310
catenifer sayi, Pituophis, 309
catervarius, Mallotus, 10–12
catesbeiana, Rana, 98, 229, 277, 310
Causus, 273
  rhombeatus, 269
cavalla, Scomberomorus, 243
Celestus, 22–23, 26
  costatus, 26
  crusculus, 27

Cemophora, 141
coccinea, 141
doliata, 141
Centropomus pectinatus, 13
cepedianus, Lophotes, 56
cephalus, Mugil, 13–15, 156, 158, 173–184
cercostigma, Cyprinella, 186
Cercaspis, 260
Cetorhinus maximus, 153–154, 156, 246
ceylonensis, Eustira, 61–62
Chaenobryttus gulosus, 67
Chaenomugil, 173, 181, 184
proboscideus, 173–183
Chamaeleolis, 145
chamaeleontides, 145
chamaeleontides, Chamaeleolis, 145
Charina, 165
bottae, 51
bottae utahensis, 309
charlesmithi, Bufo terrestris, 37–38, 85–89
Chaenobryttus coronarius, 67
chaulumnae, Latimeria, 66
Cheirodon axelrodi, 323
Chela, 61–62
laubuca, 61
Chelonia, 144, 164
Chelydra, 230
serpentina, 230
serpentina serpentina, 143, 278, 280
Chironius, 93
chiroptera, Chiropterotriton, 108
Chiropterotriton, 93, 109
chiroptera, 108
chlorobryonis, Plethodon glutinosus, 47
chloristius, Notropis analostanus, 187–188, 190, 193
chloristius, Notropis whippleianalostanus, 318
chlrobryonis, Plethodon glutinosus, 140
chloroticus, Drymobius, 94
Chrosomus eos, 161
erythrogaster erythrogaster, 53
chrysea, Lecanogaster, 204
Chrysemys, 230
picta belli, 309
picta marginata, 229
picta dorsalis, 307
chrysops, Roccus, 1–9
Cichla ocellaris, 55
Cichlasoma, 303
Cichlaurus, 303
Cichlosoma, 303
Cinctum, Heloderma, suspectum, 63
cinerea, Hyla cinerea, 275
cinereus dorsalis, Plethodon, 308
cinereus, Plethodon, 143
cinereus, Plethodon cinereus, 44, 152
cingulatum, Ambystoma, 43, 109
Cinosternum, 70
cirrigera, Eurycea bislineata, 44
Cistudo, 70
Citharichthys gilberti, 14
clamitans melanota, Rana, 46–47, 98
clamitans, Rana, 215–216, 225, 227, 228, 277, 301–310
clamitans, Rana clamitans, 47, 275
clarki, Pseudacris, 37–39, 85, 87–89
Clarazia, 70
Claudius, 93
Clemmys, 51
caspica caspica, 51
guttata, 50
clemsonae, Plethodon jordani, 94–106
clemsonae, Plethodon, 94–95
Clinostomus, 67
Cliola, 186–187
Cnemidophorus, 228, 309
inornatus, 228
perplexus, 228
sacki, 93, 228
sexlineatus, 228
tigris, 228
coccinea, Cemophora, 141
Codoma, 186–187
ornata, 186
cognatus, Bufo 37–39, 88
Coleonyx, 28
collaris, Crotaphytus, 305
Coloconger, 234–235
raniceps, 234
meadi, 234–235
colorado, Lutianus, 15
Cololabis adocetus, 57
Coluber, 92
dumfrisiensis, 141
erythrogrammus, 141
constrictor, 309
constrictor flaviventris, 309
constrictor mormon, 309
Coniophanes, 91
congestum, Moxostoma, 155
congestus, Ptychostomus, 155
Conophis, 93
conspersum, Ambystoma, 43
Constrictor, 94
constrictor, Coluber, 309
constrictor imperator, Boa, 50
constrictor flaviventris, Coluber, 309
constrictor mormon, Coluber, 309
contortix, Heterodon, 312–313
contortrix mokeson, Agkistrodon, 50
contrortrix laticinctus, Agkistrodon, 50, 310
corais couperi, Drymarchon, 50, 310
coregonus, Moxostoma, 155
coriacea, Dermochelys coriacea, 143–144, 232
coriacea, Testudo, 141
coronarius, Chaenobryttus, 67
coronata, Tantilla, 98
cornutus, Passalus, 229
Coryphaena hippurus, 156–157, 300
Corythophanes, 91
cristatus, 263
costatus, Celestus, 26
Cosymbotus, 39
platyurus, 39–41
Cottus
aleuticus, 157
asper, 15
couchi, Scaphiopus, 37, 144–145
couesii, Cryptopsaras, 238–239
couperi, Drymarchon corais, 50, 310
crepitans, Acris, 38, 46, 88, 141
crepitans, Acris gryllus, 31–36
Cricosaura, 165
crinitus, Alectis, 243
cristatus, Corythophanes, 262
cristatus, Trachypterus, 56
Crotalus, 94, 166–167, 323
atrox, 50, 265–268, 310, 314
durissus durissus, 266
horridus atricaudatus, 310
horridus horridus, 310
ruber lucasensis, 266
ruber ruber, 50, 310
stejnegeri, 167
tortugensis, 50
viridus, 314

viridis helleri, 50, 310
viridis viridis, 50, 310
Crotaphytus collaris, 305
crumenophthalmus, Selar, 243
crusculus, Celestus, 27
crucifer bartramiana, Hyla, 47, 88
crucifer, Hyla, 311
crucifer, Hyla crucifer, 31–36, 98
Cryptobranchus alleganiensis alleganiensis, 43, 46
Cryptopsaras couesii, 238–239
Cryptotis parva, 306
crysos, Caranx, 243
Crystallaria, 67
ctenolepis, Xenodexia, 300
Ctenosaura, 92, 94
curema, Mugil, 14–15, 173–184
curta, Anchovia, 14
curtus, Python curtus, 50, 310
cuvier, Galeocerdo, 156
cuvieri, Tetragonurus, 53–54
Cyanellus, Lepomis, 292
Cyclopterus lumpus, 18
cyclostigma, Liparis, 19
Cyclura, 23, 30
carinata, 24
Cynodon scomberoides, 55
cylindracea, Salamandra, 141
Cynoscion
albus, 15
nebulosus, 14
regalis, 14
Cyprinella, 185–190, 192
bubalinus, 185
cercostigma, 186
texana, 318
Cyttopsis, 237
cyrtopsis, Thamnophis, 93
Cypselurus xenopterus, 57

daguae, Gobius, 14
Dallia pectoralis, 10–12, 317
danielsi dunni, Gyrinophilus, 43, 45–46, 98
danielsi, Gyrinophilus porphyriticus, 45
Danio, 61–62
malabaricus, 62
Dasia
smaragdina, 39–41, 264
smaragdina philippinica, 39–40
Dasypeltis, 269–273, 324
inornata, 271
scabra, 269, 273
scabra loveridgei, 269
decadactylus, Beryx, 299
decagonus, Agonus, 20
Decapterus punctatus, 243
dekayi wrightorum, Storeria, 98
Delma, 28
delalandi, Typhlops, 27
deliciosa, Moniana, 318
Desmognathus brimleyorum, 46
Denisonia, 265
Denisonia superba, 265
Dendrobates, 78, 93
auro-taenia, 78
pictus, 78
ranoides, 78
talamancae, 78
tinctorius, 77
dentatus, Paralichthys, 14
Dermatemys, 91, 93
Dermochelys, 144
coriacea coriacea, 143–144, 232
Desmognathus, 44
aeneus aeneus, 44
fuscus fuscus, 43
fuscus brimleyorum, 46–47
fuscus auriculatus, 46–47
monticola, 108
monticola monticola, 98
ochrophaeus, 108
ochrophaeus carolinensis, 98
quadramaculatus, 46, 98
Devisia, 70
Diaphorolepis, 260, 323
Dibamus, 23, 30
Dicentrarchus, 1–2
Diemictylus, 44
diplana, Sphyrna, 293
Diplecogaster, 205, 207
megalops, 208
Dipsas, 92
Dipsosaurus, 218
Dispholidus, 331
Draco, 262–264
dussumieri, 263
spilopterus, 262
maculatus, 262
volans, 262, 264
draconoides, Callisaurus, 148
drobachiensis, Strongylocentrotus, 251–252
Dromicus callilaemus, 25–26
Dryadophis, 92
Drymarchon corais couperi, 50, 310
Drymobius chloroticus, 94
Dryophis nasutus, 25
doliata amaura, Lampropeltis, 50, 310
doliata annulata, Lampropeltis, 50, 310
doliata, Cemophora, 141
doliata, Lampropeltis, 141
doliata triangulum, Lampropeltis, 50, 310
dorsalis, Acris gryllus, 275
dorsalis, Chrysemys picta, 307
dorsalis, Plethodon, 44
dorsalis, Plethodon cinereus, 308
dorsalis, Salamandra, 141
douglasii, Quercus, 149
ductor, Naucrates, 156
dumerili, Squatina, 246, 248
dumerilii, Urotheca, 77
dumfrisiensis, Coluber, 141
dunni, Gyrinophilus danielsi, 43, 45–46, 98
dunni, Rana, 78–83
dunni, Sibon, 110–111
dunni, Siren, 83–85
duquesnii, Moxostoma macrolepidotum, 154
durissus, Crotalus durissus, 266
dussumieri, Draco, 263

Echis, 273
Echeneis naucrates, 59–60
egregius onocrepis, Eumeces, 324
eisenbergii, Pseudomonas, 134
elcapitanense, Syngnathus, 14
elami, Lophotes, 60
elami, Protolophotus, 60
Elape, 166
Elaphe, 166
guttata emoryi, 152
obsoleta obsoleta, 49
obsoleta quadrivittata, 50
obsoleta spiloides, 50
Electrophorus, 303
elegans vagrans, Thamnophis, 309
elegans, Pseudemys scripta, 278

Eleutherodactylus, 92
Elops, 139–140
  affinis, 15
  saurus, 139, 242
emarginatus, Lobotes, 13
emoryi, Elaphe guttata, 152
Emys blandingi, 230
Engystomops, 93
Enneacanthus obesus, 196
Enoploclytia, 136
Ensatina eschscholtzi, 108
Enyaliosaurus, 93
Enygrus, 165
eos, Chrosomus, 161
Epicrates
  angulifer, 50, 151, 310
  subflavus, 24
Epinephelus, 285
  morio, 286
  striatus, 131
  mystacinus, 286
episcopi, Brachyrhaphis, 195, 201
Episema, 186
equestris, Anolis, 145
eremicus, Peromyscus, 218
Eretmochelys squamata, 141
Erogala, 186–187
Erythrina, 144
erythrogaster, Chrosomus erythrogaster, 53
erythrogrammus, Abastor, 141
erythrogrammus, Coluber, 141
Erythrolamprus, 93
Eryx, 165
eschscholtzi, Ensatina, 108
Esox
  americanus, 67
  lucius, 11–12
  vermiculatus, 67
Etheostoma
  caeruleus caeruleus, 250
  grahami, 318
  lepidum, 318
Eucinostomus
  californiensis, 13
  pseudogula harengulus, 15
Eulamia falciformis, 246–248
Eulamia obscura, 246, 248
eulepis, Microgobius, 157
Eumeces
  egregius onocrepis, 324
  fasciatus, 280
  gaigei, 111–116, 118–120, 122
  humilis, 112
  laticeps, 98
  multivirgatus, 111–117, 120–122
  multivirgatus gaigei, 121–122
  multivirgatus multivirgatus, 121–122
  obsoletus, 324
  sumichrasti, 92
  taylori, 111, 113–117, 119–122
Eumecichthys fiski, 60
Eumicrotremus spinosus, 19
Eunotosaurus, 164
Euprotomicrus bispinatus, 58
Eurycea, 52–53
  bislineata, 98, 108
  bislineata cirrigera, 44
  bislineata wilderae, 44
  longicauda, 45
  longicauda guttolineata, 98
  lucifuga, 44–45
  multiplicata, 108
  neotenes, 43
  tynerensis, 43, 52
Eustira, 61–62
  ceylonensis, 61–62
  maassi, 61
Euthynnus alleteratus, 157
Evorthodus lyricus, 157
exasperatum, Heloderma horridum, 63
eximia, Hyla, 93
Exocoetus sp, 57

fabricii, Lumpenus, 18
falcata, Seriola, 156
falciformis, Eulamia, 246–248
fasciata, Natrix sipedon, 47
fasciata, Seriola, 156
fasciatus, Eumeces, 280
fasciatus, Pholis, 18
felis, Felichthys, 298
felis, Galeichthys, 295, 297–298
femoralis, Hyla, 33
femoralis, Phyllobates, 77, 78
feriarum, Pseudacris, 45–46
ferox, Alepisaurus, 298–299
festiva, Ameiva, 92
feriarum, Pseudacris nigrita, 31–32, 34–36, 46, 311–312
Ficimia, 93
filamentosum, Brachyplatystoma, 56
Fimbrios, 260
fisheri, Rana, 218
fiski, Eumecichthys, 60
Fistularia, 140
fitchi, Thamnophis sirtalis, 309
flavescens, Kinosternon flavescens, 278, 280
flavipunctatus, Aneides, 108
flaviventris, Coluber constrictor, 309
floridana, Lampropeltis getulus, 50
flotator, Phyllobates, 78
fluviatilis, Achirus, 13, 15
fontinalis, Salvelinus, 17
formosus, Sceloporus, 93
fowleri, Bufo, 211
fowleri, Bufo woodhousei, 31, 98
fragilis, Anguis, 23, 27
franciscanus, Strongylocentrotus, 251
frenatus, Hemidactylus, 39–41
fulviceps, Rhadinaea pachyura, 77
Fundulus, 195–196
  heteroclitus, 196
furthii, Ilisha, 14
fuscus auriculatus, Desmognathus, 46–47
fuscus brimleyorum, Desmognathus, 46–47
fuscus, Desmognathus fuscus, 43
fuscus, Pelobates, 310

gaigei, Eumeces, 111–116, 118–120, 122
gaigei, Eumeces multivirgatus, 121–122
gaigei, Gambusia, 299–300
garthi, Callionymus, 159–160
Galea, 233
Galeoidea, 294
Galeocerdo cuvier, 156
galapagensis, Alphestes, 285
galacturus, Notropis, 187–190, 192–193
Galeichthys felis, 295, 297–298
Gambusia, 195, 300
  alvarezi, 299–300
  affinis, 299
  gaigei, 299–300
  heterochir, 299–300
  hurtadoi, 299–300
  senilis, 299

Gasterosteus, 58
Gecarcinus ruricoli, 151
Gehyra mutilata, 39–41
Gempylus, 304–305, 322
  serpens, 322
Germo alalunga, 239
geronimensis, Anniella, 150
Gerres brevimanus, 13
Gerrhonotus, 25
  albigularis, 26
  multicarinatus, 148
getulus floridana, Lampropeltis, 50
getulus holbrooki, Lampropeltis, 50, 310
gibbosus, Lepomis, 290–291
gigas, Arapaima, 54–56
Gila, 67
gilberti, Citharichthys, 14
glauca, Prionace, 61, 246–247
glutinosus chlorobryonis, Plethodon, 47, 140
glutinosus grobmani, Plethodon, 47
glutinosus, Plethodon, 46–47, 102, 106, 140–141
glutinosus, Plethodon glutinosus, 46–47, 98–99, 140
Gnathonemus, 303
Gobiesox, 241
Gobiesox maeandricus, 241–242
Gobionellus
  boleosoma, 157
  shufeldti, 14
Gobius daguae, 14
  paganellus, 131, 196
Gogius, 196
gomesi, Ophichthus, 61
Gopherus, 218, 307
  agassizi, 307
  berlandieri, 307
  polyphemus, 307
Gouania, 205, 207
gracile, Ambystoma, 109
gracilis, Sceloporus graciosus, 263
gracilis taylori, Brachymeles, 144
gracilis, Opeatogenys, 206
graciosa, Uta, 148
graciosus gracilis, Sceloporus, 263
graciosus, Sceloporus, 148
grahami, Etheostoma, 318
granuliventris, Hyloxalus, 77
gratiosa, Hyla, 45
greeni, Rana, 316
griseus, Lutianus, 13
griseus, Hexanchus, 246
grobmani, Plethodon glutinosus, 47
grylio, Rana, 215–216, 277
Gryllus, 229
gryllus, Acris gryllus, 46
gryllus crepitans, Acris, 31–36, 46
gryllus dorsalis, Acris, 275
gulosus, Chaenobryttus, 67
gunnelus, Pholis, 18
guttata emoryi, Elaphe, 152
guttata, Clemys, 50
guttolineata, Eurycea longicauda, 98
Gymnacanthus tricuspis, 19
Gymnarchus, 303
Gymnophthalmus, 93
Gymnura altavela, 156
Gyrinophilus
  danielsi dunni, 43, 45–46, 98
  palleucus, 43
  porphyriticus, 45
  porphyriticus danielsi, 45

Hadropterus, 67
Haliastur indus, 231
halophilus, Bufo boreas, 146
hammondi, Scaphiopus, 82, 144–145, 308
hammondi, Scaphiopus hammondi, 145
hankinsoni, Hybognathus, 161
hannah, Ophiophagus, 271
Haplochromis, 162
hardyi, Aneides, 108
harengulus, Eucinostomus pseudogula, 15
haydeni, Ptychostoma, 154–155
haydeni, Teretulus, 154
heckscheri, Rana, 274–276
Helicops, 260
helleri, Xiphophorus, 299
helleri, Crotalus, viridis, 50, 310
Heloderma, 20, 22–23, 25, 27, 63–64, 218
  suspectum, 22, 63
  suspectum cinctum, 63
  horridum, 63
  horridum alvarezi, 63
  horridum exasperatum, 63
Hemidactylus frenatus, 39–41
Hemidactylium scutatum, 44, 108, 142
hemiodon, Hypoprion, 160
Heros, 303
hesterna, Siren, 83
heterochir, Gambusia, 299–300
heteroclitus, Fundulus, 196
Heterodon, 313
  browni, 312–313
  contortix, 312–313
  platyrhinos, 98, 312–313
  simus, 229
Hexanchus griseus, 246
Hippocampus hudsonius, 156
Hippoglossus hippoglossus, 157
hippoglossoides, Reinhardtius, 19
hippos, Caranx, 243
hippurus, Coryphaena, 156–157, 300
Holbrookia, 324
holbrooki, Lampropeltis getulus, 50, 310
holbrooki, Scaphiopus, 45
holbrooki, Scaphiopus holbrooki, 31, 276
holbrooki hurteri, Scaphiopus, 38
horridus atricaudatus, Crotalus, 310
holmesi, Microgobius, 157
Hoplostethus mediterraneus, 156
horridus, Crotalus horridus, 310
horridum alvarezi, Heloderma, 63
horridum exasperatum, Heloderma, 63
horridum, Heloderma, 63
hospes, Mugil, 173–183
houstonensis, Bufo, 210–211
hubbsi, Anoptichthys, 123
hubbsi, Novumbra, 248
humilis, Eumeces, 112
humilis, Leptotyphlops, 28
hurtadoi, Gambusia, 299–300
hurteri, Scaphiopus, 144
hurteri, Scaphiopus holbrooki, 38
hudsonius, Hippocampus, 156
Hybopsis, 186, 250
  biguttatus, 250
  micropogon, 250
  plumbea, 67
Hybognathus
  hankinsoni, 161
  nuchalis, 67
  placita, 67
Hyla, 92–93
  andersoni, 31–36, 141
  arenicolor, 309

eximia, 93
cinerea cinerea, 275
crucifer, 311
crucifer bartramiana, 47, 88
crucifer crucifer, 31–36, 98
femoralis, 33
gratiosa, 45
leucophyllata, 92
miotympanum, 323
ocularis, 88
regilla, 31, 221, 225, 309, 317
rubra, 93
septentrionalis, 151
versicolor, 37
versicolor versicolor, 31–36, 88, 98
zonata, 322
Hyloxalus, 77
granuliventris, 77
palmatus, 77
Hydromantes italicus, 317
Hypentelium nigricans, 250
Hyphessobrycon cardinalis, 323
Hypoprion, 160
hemiodon, 160
longirostris, 160
macloti, 160
playfairii, 160
signatus, 160, 242, 300
Hypsilepsis, 186

Icelus spatula, 19
Ictalurus, 67
idahoensis, Plethodon vandykei, 147–148
Ijimaia antillarum, 234–235
Ilisha furthii, 14
imbricata, Testudo, 141
imperator, Boa constrictor, 50
indus, Haliastur, 231
inguinalis, Prostherapis, 77
Inoceramus, 136
inornata, Dasypeltis, 271
inornata, Uma, 148
inornatus, Cnemidophorus, 228
interrupta, Morone, 67
interrupta, Perca mitchilli, 1
interruptus, Roccus, 1–9
isodon, Aprindon, 293
Isurus oxyrinchus, 303
italicus, Hydromantes, 317

jamaicensis, Typhlops, 27–28
jeffersonianum, Ambystoma, 141–142
Jenynsia, 197, 201–202
lineata, 195, 197, 203
jicari, Lialis, 230–231
jordani, Anoptichthys, 129–130, 132
jordani clemsonae, Plethodon, 94–106
jordani, Pantosteus, 161
jordani, Plethodon, 95, 98–99, 101, 105
jordani rabunensis, Plethodon, 95, 98, 105
jordani teyahalee, Plethodon, 95, 105
Joturus, 173
Julidochromis, 162

kalmi, Pseudacris nigrita, 312
Katsuwonus pelamis, 242
Kaupichthys, 234
Kerodon, 233
Kinosternon flavescens flavescens, 278, 280
koefoedi, Liparis, 19

labrax, 9
labrax, Roccus,
bimaculatus, 303
punctata, 303
lanceolata, Pontederia, 275
lacepedei, Lophotus, 60
Lacerta, 315
Lachesis muta, 233
Laemanctus, 93
laevis, Phoxinus, 195
laevis, Raja, 246
Lagidium, 233
Lagostomus, 233
maximus, 233
lalandi, Scoliodon, 247
Laminospondylus, 136, 138–139
transversus, 136, 138–139
Lampetra aepyptera, 54
Lamprolongus, 162
Lampropeltis, 141
calligaster calligaster, 48
doliata, 141
doliata amaura, 50, 310
doliata annulata, 50, 310
doliata triangulum, 50, 310
getulus floridana, 50
getulus holbrooki, 50, 310
Lanthanotus, 20–30, 63
laticeps, Eumeces, 98
laticinctus, Agkistrodon contortrix, 50, 310
Latimeria, 67
chaulumnae, 66
latinasus, Phyllobates, 78
latipinna, Mollinensia, 15
laubuca, Chela, 61
Laubuca, 61
laxa, Myosotis, 142
Lebistes reticulatus, 134, 299
Lecanogaster chrysea, 204
lecontei, Rhinocheilus lecontei, 50, 310
leedsi, Notropis, 187–191, 193
Leiocephalus, 264
Leiostomus xanthurus, 14–15
Lepadogaster, 204, 207
lepadogaster, 204, 208
lepadogaster lepadogaster, 208
lepadogaster purpurea, 208
lepidum, Etheostoma, 318
Lepomis
cyanellus, 292
gibbosus, 290–291
macrochirus, 290–291
microlophus, 290–291
Leptoclinus maculatus, 19
Leptocottus, 241
armatus armatus, 241–242
Leptodactylus, 94
bufonius, 233
Leptophis, 91
Leptolepis
bronni, 139
macrophthalmus, 135, 139
Leptotyphlops, 28, 30
humilis, 28
Lethrinops, 162
Leuciscus, 186
bubalinus, 185–186
lutrensis, 185–186, 190
leucophyllata, Hyla, 92
Lialis, 230, 28
burtoni, 230–231
jicari, 230–231
Lichanura, 165
limnocharis, Rana, 316
limnocharis, Rana limnocharis, 316
Limnochromis, 162

lineata, Jenynsia, 195, 197, 203
lineolata, Sarda, 239
Liotyphlops, 26
Liparis atlanticus, 18
  tunicatus, 19
  cyclostigma, 19
  koefoedi, 19
littoralis, Callichthys, 55
Lobotes
  emarginatus, 13
  surinamensis, 13, 15
longicauda, Eurycea, 45
longicauda guttolineata, Eurycea, 98
longicaudus, Spelerpes, 45
longimanus, Pterolamiops, 58
longimanus, Pterolamiops, 60
longimanus, Pterolamiops, 247
longirostris, Hypoprion, 160
Lophotus
  capelli, 60
  cepedianus, 56
  elami, 60
  lacepedei, 60
loveridgei, Dasypeltis scabra, 269
Loxocemus, 165
  bicolor, 50, 310
lucasensis, Crotalus ruber, 266
lucifuga, Eurycea, 44–45
lucius, Esox, 11–12
lugubris, Aneides, 108
Lumpenus
  fabricii, 18
  lumpretaeformis, 18
  medius, 18
lumpretaeformis, Lumpenus, 18
lumpus, Cyclopterus, 18
lupus, Anarhichas, 240
Lutianus
  analis, 243
  argentiventris, 13
  colorado, 15
  griseus, 13
  novemfasciatus, 15
lutrensis, Leuciscus, 185–186, 190
lutrensis, Moniana, 185, 187
lutrensis, Notropis, 185–189, 191–192
Luxilus, 186–187
Lycodes
  pallidus, 18–19
  reticulatus, 19
  turneri turneri, 19
Lycosa, 229
lyricus, Evorthodus, 157

maassi, Eustira, 61
mabeei, Ambystoma, 43, 109
machnata, Elops, 184
macloti, Hypoprion, 160
Macrochelys temmincki, 234
macrochirus, Lepomis, 290–291
Macrocnemus, 70
macrodactylum, Ambystoma, 109, 308
macrolepidotum duquesnii, Moxostoma, 154
macrolepidotum, Moxostoma, 155
macrophthalmus, Leptolepis, 135, 139
macropterus, Neothunnus, 239
maculatum, Ambystoma, 98, 142
maculatus, Draco, 262
maculatus, Leptoclinus, 19
maculatus, Trinectes, 13–15
maculatus, Xiphophorus, 299
maeandricus, Gobiesox, 241–242
maenas, Carcinides, 156
major, Terrapene, 280
malabaricus, Danio, 62
Malania anjouanae, 66
malaventris, Plethodon shermani, 95, 97–98, 102–107
Mallotus
  catervarius, 10–12
  villosus, 10, 12
Manculus, 109
  quadridigitatus, 108
maniculatus bairdii, Peromyscus, 306
marcianus nigrolateris, Thamnophis, 143
marcianus, Thamnophis, 143
Marcusenius, 303
marginata, Chrysemys picta, 229
marginatus, Stereochilus, 44, 108
marinus, Bagre, 298
marinus, Petromyzon, 244
marmoratus, Scorpaenichthys, 251
Masticophis, 92, 94
maximus, Cetorhinus, 153–154, 156, 246
maximus, Lagostomus, 233
mazatlanus, Achirus, 13
meadi, Coloconger, 234–235
mearnsi, Uta, 148
mediterraneus, Hoplostethus, 156
medius, Lumpenus, 18
Megalops, 137, 139
  atlanticus, 139–140
megalops, Diplecogaster, 208
megapoda, Rana, 78–82
Melaleuca, 231
meleagris, Stomolophus, 232
melanoleuca, Naja, 50, 310
melanoleucus mugitus, Pituophis, 310
melanoleucus, Pituophis melanoleucus, 50, 310
melanops, Minytrema, 154–155
melanorhinus, Phyllobates, 77
Melanosaurus, 21, 25
melanostictum, Ambystoma tigrinum, 308
melanostictus, Bufo, 46–147
melanota, Rana clamitans, 46, 47, 98
metcalfi, Plethodon, 94–95
mexicanus, Astyanax, 123, 133
Microcavia, 233
microdon, Pristis, 13–14
Microgadus tomcod, 156
Microgobius
  eulepis, 157
  holmesi, 157
  miraflorensis, 14
  thalassinus, 157
Microhyla, 38
  carolinensis olivacea, 37, 88
Microlophichthys microlophus, 238
microlophus, Lepomis, 290–291
microlophus, microlophichthys, 238
micropogon, Hybopsis, 250
Micropogon undulatus, 14
micropterus, Oxyporhamphus, 56–57
Micropterus salmoides, 290
microscaphus, Bufo, 208–212
microscaphus, Bufo woodhousei, 212
Micrurus nigrocinctus, 94
miliarius, Sistrurus, 167
Minnilus, 186–187
Minytrema, 155
  melanops, 154–155
Miobatrachus, 69
miotympanum, Hyla, 323

miraflorensis, Microgobius, 14
mississippiensis, Roccus, 67
Mitchilli interrupta, Perca, 1
mokeson, Agkistrodon contortrix, 50
Mola mola, 250
Mollinensia latipinna, 15
Moloch, 166
Molochus, 166
molurus bivittatus, Python, 50, 310
molurus, Python, 24–25
Moniana, 185–187
  deliciosa, 318
  lutrensis, 185, 187
monitor, Varanus, 22–23, 25
montanus, Ascaphus truei, 308
montanus, Pseudotriton, 47
montanus, Pseudotriton montanus, 47, 141, 152–153
montezumae, Rana, 78–83
monticola, Desmognathus, 108
monticola, Desmognathus monticola, 98
moreleti, Agalychnis, 94
morio, Epinephelus, 286
mormon, Coluber constrictor, 309
Mormyrops, 303
Mormyrus, 303
Morone, 1–2, 73
  americanus, 9
  interrupta, 67
mortoni, Ptychodus, 136
Moxostoma, 154–155
  aureolum, 154–155
  breviceps, 155
  carinatum, 154
  congestum, 155
  coregonus, 155
  macrolepidotum, 155
  macrolepidotum duquesnii, 154
  rubreques, 154
  valenciennesi, 154
  victoriae, 154–155
mucosus, Ptyas, 25
Mugil, 173, 175, 181, 302
  capito, 14
  cephalus, 13–15, 156, 158, 173–184
  curema, 14–15, 173–184
  hospes, 173–183
  peruanus, 173, 181
  rammelsbergi, 173–174, 178–183
  setosus, 173–174, 177–182
mugitus, Pituophis melanoleucus, 310
Mullus auratus, 243
multicarinatus, Gerrhonotus, 148
multiguttatus, Alphestes, 285
multiplicata, Eurycea, 108
multivirgatus, Eumeces, 111–117, 120–122
multivirgatus, Eumeces multivirgatus, 121–122
multivirgatus gaigei, Eumeces, 121–122
Musa textilis, 144
muta, Lachesis, 233
mutilata, Gehyra, 39–41
Myctophum affine, 317
Myosotis laxa, 142
Myoxocephalus
  quadricornis, 18, 10–12
  scorpius, 18
  scorpioides, 18
mystacinus, Epinephelus, 286
Myxostoma macrolepidotum, 155

Naja melanoleuca, 50, 310
Naja nitricollis, 50, 310
narinari, Aetobatus, 156
nasutus, Dryophis, 25
nasutus, Nesiarchus, 304
nasutus, Ophioseps, 29
Natrix
  sipedon fasciata, 47
  sipedon pictiventris, 275
  sipedon pleuralis, 47
Naucrates ductor, 156
naucrates, Echeneis, 59–60
Nealotus tripes, 304, 305
nebulata, Sibon, 111
nebulosus, Cynoscion, 14
Necturus, 41, 52
neogaea, Pfrille, 161
neotenes, Eurycea, 43
Neothunnus macropterus, 239
Nesiarchus nasutus, 304
nicefori, Phyllobates, 77
Nicoria, 70
nigra, Anniella pulchra, 150
nigricans, Hypentelium, 250
nigrita feriarum, Pseudacris, 31–32, 34–36, 311–312
nigrita kalmi, Pseudacris, 312
nigrita, Pseudacris, 311, 318
nigrita triseriata, Pseudacris, 85–89, 311–312
nigrocinctus, Micrurus, 94
nigrolateris, Thamnophis marcianus, 143
Ninia, 91
nitricollis, Naja, 50, 310
niveus, Notropis, 188–191, 193
noctilucus, Pyrophorus, 151
non-liquifaciens, Pseudomonas, 134
norvegicus, Rattus, 151
Notechis scutatus, 265, 266
Notelops bramma, 139
notha, Acinacea, 322
Nothopsis, 255–256, 258–261
  affinis, 255–256, 259, 261
  rugosus, 255, 257, 259
  torresi, 255–257, 259, 261
Notropis, 185–188, 191
  analostanus, 189, 191
  analostanus analostanus, 188, 190–193
  analostanus chloristius, 187–188, 190, 193
  bifrenatus, 196, 318
  caeruleus, 187–190, 192–193
  callisema, 187–191, 193
  callistius, 187–191, 193
  callitaenia, 187–191, 193
  camurus, 187–190, 193
  galacturus, 187–190, 192–193
  leedsi, 187–191, 193
  lutrensis, 185–189, 191–192
  niveus, 188–191, 193
  ornatus, 185, 187, 189, 192
  pyrrhomelas, 188–192
  rubellus, 250, 286–290
  spilopterus, 188–193
  trichroistius, 187–191, 193
  whipplei, 188–189, 191, 193
  whippleianalostanus chloristius, 318
  venustus, 187–190, 192–193
  xaenurus, 187–192
Noturus, 67
novemfasciatus, Lutianus, 15
Novumbra hubbsi, 248
nuchalis, Hybognathus, 67
nybelini, Triglops, 18

obestetricans, Alytes, 65
obesus, Enneacanthus, 196
obscura, Eulamia, 246, 248

obsoleta, Elaphe obsoleta, 49
obsoleta spiloides, Elaphe, 50
obsoletus, Eumeces, 324
occidentalis, Sceloporus, 148
ocellaris, Cichla, 55
ocellatus, Ophichthus, 286
ochrophaeus carolinensis, Desmognathus, 98
ochrophaeus, Desmognathus, 108
ocularis, Hyla, 88–89
odoratus, Sternotherus, 230
Oedipina parvipes, 258
olivacea, Microhyla carolinensis, 37, 88
olriki, Aspidophoroides, 20
onca, Rana, 218
Oncorhynchus, 245
Oneirodes acanthias, 238
onocrepis, Eumeces egregius, 324
opacum, Ambystoma, 109
Opeatogenys, 206, 205, 207
cadenati, 206
gracilis, 206
Opetiosaurus, 25
Ophichthus
gomesi, 61
ocellatus, 286
Ophiophagus hannah, 271
Ophioseps nasutus, 28–29
Ophisaurus, 27, 29
Ophthalmochromis ventralis, 162
ornata, Codima, 186
ornata, Pseudacris, 88
ornata, Terrapene, 317
ornata, Terrapene ornata, 278, 280
ornatus, Notropis, 185, 187, 189, 192
Orohippus, 83
Osteoglossum bicirrhosum, 55
Otophidium welshi, 244
ouachitae, Plethodon, 47, 106
Oxyporhamphus micropterus, 56–57
oxyrinchus, Isurus, 303

pachyura fulviceps, Rhadinaea, 77
pacificus, Batrachoseps, 108
pacificus, Parazen, 235–237
paganellus, Gobius, 131, 196
Paliguana, 70
palleucus, Gyrinophilus, 43
pallidus, Lycodes, 18–19
palmatus, Hyloxalus, 77
palustris, Rana, 46, 47, 98, 215–216
panamensis, Achirus, 14
Pantosteus jordani, 161
Paralichthys albiguttus, 14
dentatus, 14
Parazen, 236
pacificus, 235–237
parietalis, Thamnophis sirtalis, 309
parva, Cryptotis, 306
parvipes, Oedipina, 258
pectinatus, Centropomus, 13
pectinatus, Pristis, 13
pectoralis, Dallia, 10–12, 317
pelamis, Katsuwonus, 242
Pelobates
fuscus, 310
syriacus, 310–311
Peltosaurus, 25
Perca mitchilli interrupta, 1
Percina, 67
Perilampus, 61
Periplaneta, 145
americana, 151
Perissodus, 162
Peromyscus eremicus, 218
Peromyscus maniculatus bairdii, 306
perplexus, Cnemidophorus, 228
peruanus, Mugil, 173, 181
Petrocephalus, 303
Petromyzon marinus, 244
Pfrille neogaea, 161
philippinica, Dasia smaragdina, 39–40
Pholis
fasciatus, 18
gunnellus, 18
Photogenis, 186–187
spilopterus, 187
stigmaturus, 187
Phoxinus, 58
laevis, 195
Phrynosoma, 331
Phyllobates, 77–78
beatriciae, 78
bicolor, 77
boulengeri, 78
brunneus, 77
femoralis, 77, 78
flotator, 78
latinasus, 78
melanorhinus, 77
nicefori, 77
pratti, 78
subpunctatus, 78
Phyllonycteris poeyi, 50, 151
Phylobates subpunctatus, 78
Physa, 82, 133
Physalaemus, 323
picta belli, Chrysemys, 309
picta dorsalis, Chrysemys, 307
picta marginata, Chrysemys, 229
picta, Testudo, 141
pictiventris, Natrix sipedon, 275
pictus, Dendrobates, 78
Pilodictis, 67
pingeli, Triglops, 19
pipiens brachycephala, Rana, 309
pipiens berlandieri, Rana, 37
pipiens, Rana, 31, 78–79, 81, 98, 212–215, 217–218, 220, 311
pipens, Rana pipiens, 43, 212
pipiens sphenocephla, Rana, 212
pipiens syphenocephala, Rana, 275
piscivorus, Agkistrodon, 47, 266
Pituophis, 94
catenifer annectens, 50, 310
catenifer sayi, 309
melanoleucus melanoleucus, 50, 310
melanoleucus mugitus, 310
placita, Hybognathus, 67
Planorbis, 133
Plargyrus, 186
Platypeltis, 166
platyrhinos, Heterodon, 98, 312–313
platyurus, Cosymbotus, 39–41
playfairii, Hypoprion, 160
Plecodus, 162
Plectrohyla, 91
Plethodon, 107–109, 317
caddoensis, 47
cinereus, 143
cinereus cinereus, 44, 152
cinereus dorsalis, 308
clemsonae, 94–95
dorsalis, 44
glutinosus, 46–47, 102, 106, 140–141
glutinosus chlorobryonis,47, 140

glutinosus glutinosus, 46–47, 98, 99, 140
glutinosus grobmani, 47
jordani, 95, 98–99, 101, 105
jordani clemsonae, 94–106
jordani rabunensis, 95, 98, 105
jordani teyahalee, 95, 105
metcalfi, 94–95
ouachitae, 47, 106
richmondi, 48
shermani, 95
shermani malaventris, 95, 97–98, 102–107
vandykei idahoensis, 147–148
yonahlossee, 106
pleuralis, Natrix sipedon, 47
pleurospilus, Callochromis, 162
plumbea, Hybopsis, 67
poeyi, Phyllonycteris, 50, 151
Pollachius virens, 246
polyphemus, Gopherus, 307
Pomadasys bayanus, 15
Poronotus, 59
porphyriticus danielsi, Gyrinophilus, 45
porphyriticus, Gyrinophilus, 45
porphyriticus, Pseudechis, 265
pratti, Phyllobates, 78
pretiosa, Rana, 151
pretiosa, Rana pretiosa, 309, 324
Prionace glauca, 61, 246–247
Prionotus scitulus scitulus, 157
tribulus tribulus, 157
Pristis microdon, 13–14
pectinatus, 13
proboscideus, Chaenomugil, 173–183
Prolacerta, 70
Prostherapis, 77–78
inguinalis, 77
Proteus, 41
anguinus, 317
Protobatrachus, 69
Protolophotus, 60
elami, 60
Pseudacris, 32–35
brachyphona, 45–46
clarki, 37–39, 85, 87–89
feriarum, 45–46
nigrita, 311, 318
nigrita feriarum, 31–32, 34–36, 311–312
nigrita kalmi, 312
nigrita triseriata, 85–89, 311–312
ornata, 88
streckeri, 85–89
streckeri streckeri, 38
triseriata, 89
Pseudechis, 265
porphyriticus, 265
Pseudemys scripta elegans, 275, 278
Pseudoeurycea, 91, 93
pseudogula harengulus, Eucinostomus, 15
Pseudomonas eisenbergii, 134
non-liquifaciens, 134
Pseudopentaceros, richardsoni, 244–245
Pseudopriacanthus altus, 156, 241
Pseudotriton, 152
montanus, 47
montanus montanus, 47, 141, 152–153
ruber, 141
ruber ruber, 152–153
ruber schencki, 45, 98
Pterolamiops longimanus, 58, 60, 247
Ptyas mucosus, 25
Ptychodus, 136
mortoni, 136
Ptychostoma haydeni, 154–155
Ptychostomus congestus, 155
pulchra, Anniella, 148, 150
pulchra, Anniella pulchra, 148, 150
pulchra nigra, Anniella, 150
punctata, Labrus, 303
punctatus, Bufo, 209–210
punctatus, Decapterus, 243
punctatus, Roccus, 1–9
punctatus, Typhlops, 27
purpurea, Lepadogaster lepadogaster, 208
Pygopus, 28
Pylodictis, 67
Pyrophorus noctilucus, 151
pyrrhomelas, Notropis, 188–192
Python argus, 25
curtus curtus, 20, 310
molurus, 24–25
molurus bivittatus, 50, 310
regius, 50, 310
sebae, 50, 310

quadracus, Apeltes, 195
quadramaculatus, Desmognathus, 46, 98
quadricornis, Myoxocephalus, 10–12, 18
quadridigitatus, Manculus, 108
Quinquarius, 245
capensis, 245

rabunensis, Plethodon jordani, 95, 98, 105
Rachycentron canadus, 243
Radinaea, 77
Raja laevis, 246
rammelsbergi, Mugil, 173–174, 178–183
Rana, 31, 94
areolata, 38–39, 47
capito, 215–216
capito sevosa, 47
catesbeiana, 98, 229, 277, 310
clamitans, 215–216, 225, 227, 277, 309, 310
clamitans clamitans, 47, 275
clamitans melanota, 46, 47, 98
dunni, 78–83
fisheri, 218
greeni, 316
grylio, 215–216, 277
heckscheri, 274–276
limnocharis, 316
limnocharis limnocharis, 316
megapoda, 78–82
montezumae, 78–83
onca, 218
palustris, 46, 47, 98, 215–216
pipiens, 31, 78–79, 81, 98, 212–215, 217–218, 220, 311
pipiens berlandieri, 37
pipiens brachycephala, 309
pipiens pipiens, 43, 212
pipiens sphenocephla, 212
pipiens syphenocephala, 275
pretiosa, 151
pretiosa pretiosa, 309, 324
sylvatica, 142, 150–151, 215–216
sylvatica sylvatica, 33, 98
venulosa, 322
virgatipes, 31, 215, 216
raniceps, Coloconger, 234
ranoides, Dendrobates, 78
rathbuni, Typhlomolge, 41, 43, 108
regalis, Cynoscion, 14
regilla, Hyla, 31, 221, 225, 309, 317
regius, Python, 50, 310
Reinhardtius hippoglossoides, 19

Remora, 59–60
  australis, 157
  remora, 58–60
repens, Aprasia, 28
reticulatus, Lebistes, 134, 299
reticulatus, Lycodes, 19
Rhacophorus, 316
Rhadinaea pachyura fulviceps, 77
Rhincodon typus, 157
Rhineura, 28
Rhinocheilus lecontei lecontei, 50, 310
Rhinophis, 25–27
rhombeatus, Causus, 269
richardsoni, Pseudopentaceros, 244–245
richmondi, Plethodon, 48
robalito, 13–15
robalito, Centropomus, 13–15
Roccus, 1–4, 67
  americanus, 1–9
  chrysops, 1–9
  interruptus, 1–9
  labrax, 1–9
  mississippiensis, 67
  punctatus, 1–9
  saxatilis, 1–9
rubellus, Notropis, 250, 286–290
ruber, Crotalus ruber, 50, 310
ruber lucasensis, Crotalus, 266
ruber, Pseudotriton, 141
ruber, Pseudotriton ruber, 152–153
ruber schencki, Pseudotriton, 45, 98
ruber sticticeps, Spelerpes, 141
rubra, Hyla, 93
rubreques, Moxostoma, 154
rugosus, Nothopsis, 255, 257, 259
ruricoli, Gecarcinus, 151

sacki, Cnemidophorus, 93, 228
saida, Boreogadus, 10–12, 19
Salamandra
  cylindracea, 141
  dorsalis, 141
  variolata, 140
salar, Salmo salar, 240
saliens, Thunnus, 239
salmoides, Micropterus, 290
Salmo salar salar, 240
salvator, Varanus, 22
Salvelinus
  alpinus, 17
  fontinalis, 17
sanniola, Sibon, 111
sapidissima, Alosa, 252
Sarda lineolata, 239
  sarda, 156, 243
Sauromalus, 218
saurus, Elops, 139, 242
saurus, Scomberesox, 56
saxatilis, Roccus, 1–10
sayi, Pituophis catenifer, 309
scabra, Dasypeltis, 269, 273
scabra loveridgei, Dasypeltis, 269
Scaphiopus, 31, 33, 229, 323
  bombifrons, 37–38, 145
  couchi, 37, 144–145
  hammondi, 144–145, 82
  hammondi hammondi, 145
  holbrooki, 45, 229
  holbrooki holbrooki, 276
  holbrooki hurteri, 38
  hurteri, 144
Scartomyzon, 155
Sceloporus, 91, 93, 148, 309
  formosus, 93
  graciosus, 148
  graciosus gracilis, 263
  occidentalis, 148
  siniferus, 93
  teapensis, 92
  variabilis, 93
schencki, Pseudotriton ruber, 45, 98
Schilbeodes, 67
schistosa, Tantilla, 93
schistosum, Atrētium, 25
scholanderi, Alphestes, 283–286
scitulus, Prionotus scitulus, 157
Scoliodon, 294
  lalandi, 247
  terrae-novae, 246–247, 293
Scomberesox saurus, 56
scomberoides, Cynodon, 55
Scomberomorus cavalla, 243
Scorpaenichthys marmoratus, 251
scorpioides, Myoxocephalus, 18
scorpius, Myoxocephalus, 18
scripta elegans, Pseudemys, 278, 275
scrutator, Strongylura, 14
scutatum, Hemidactylium, 44, 108, 142
scutatus, Notechis, 265
sebae, Python, 50, 310
Sebastodes, 57
Selar crumenophthalmus, 243
Semotilus atromaculatus, 53
senilis, Gambusia 299
septentrionalis, Hyla, 151
Seriola falcata, 156
  fasciata, 156
  zonata, 156
serpens, Gempylus, 322
serpentina, Chelydra, 230
serpentina, Chelydra serpentina, 143, 278, 280
serpentina, Testudo, 141
setosus, Mugil, 173–174, 177–182
sevosa, Rana capito, 47
sexlineatus, Cnemidophorus, 228
shermani malaventris, Plethodon, 95, 97–98, 102–107
shermani, Plethodon, 95, 107
Shinisaurus, 20–23, 25, 30
shufeldti, Gobionellus, 14
Sibon, 109–111
  dunni, 110–111
  nebulata, 111
  sanniola, 111
Sibynophis, 24
signatus, Hypoprion, 160, 242, 300
simpsoni, Siren, 83
simus, Heterodon, 229
siniferus, Sceloporus, 93
sipedon fasciata, Natrix, 47
sipedon pictiventris, Natrix, 275
sipedon pleuralis, Natrix, 47
Siren
  hesterna, 83
  simpsoni, 83
sirtalis fitchi, Thamnophis, 309
sirtalis parietalis, Thamnophis, 309
Sistrurus, 166–167, 323
  miliarius, 167
  dunni, 83–85
smaragdina, Dasia, 39–41, 264
smaragdina philippinica, Dasia, 39–40
spatula, Icelus, 19
spelaeus, Typhlotriton, 108

Spelerpes longicaudus, 45
  ruber sticticeps, 141
Sphenodon, 22, 70
sphenocephla, Rana pipiens, 212
Sphyraena borealis, 242
Sphyrna diplana, 293
Sphyrnidae, 294
spiloides, Elaphe obsoleta, 50
spilopterus, Draco, 262
spilopterus, Notropis, 188–193
spilopterus, Photogenis, 187
spinifera, Trionyx, 232
spinosus, Eumicrotremus, 19
splendens, Beryx, 298–299
squamata, Eretmochelys, 141
Squatina dumerili, 246, 248
stansburiana, Uta, 148
Staurotypus, 91, 93
stejnegeri, Crotalus, 167
Stellifer
  furthii, 14
  melancheir, 14
Stereochilus marginatus, 44, 108
Stereogenys, 164
Sternotherus odoratus, 230
sticticeps, Spelerpes ruber, 141
stigmaturus, Photogenis, 187
Stoliczkaia, 260
Stolothrissa, 162
Stomolophus meleagris, 232
Storeria dekayi wrightorum, 98
streckeri, Pseudacris, 85–89
streckeri, Pseudacris streckeri, 38
striatus, Epinephelus, 131
Strongylocentrotus drobachiensis, 251–252
  franciscanus, 251
Strongylura scrutator, 14
subflavus, Epicrates, 24
subpunctatus, Phyllobates, 78
sumichrasti, Eumeces, 92
superba, Denisonia, 265
surinamensis, Lobotes, 13 15
suspectum cinctum, Heloderma, 63
suspectum, Heloderma, 22, 63
sylvatica, Rana, 142, 150–151, 215–216
sylvatica, Rana sylvatica, 33, 98,
Synanceja verrucosa, 249
Syngnathus elcapitanense, 14
Synophis, 260
syphenocephala, Rana pipiens, 275
Syphyrna tiburo, 293
syriacus, Pelobates, 310–311

taenia Trachypterus, 56
talpoideum, Ambystoma, 109
Tantilla
  coronata, 98
  schistosa, 93
Tanystropheus, 70
Taractes asper, 323
taurus, Carcharias, 156
taylori, Brachymeles gracilis, 144
taylori, Eumeces, 111, 113–117, 119–122
teapensis, Sceloporus, 92
telamancae, Dendrobates, 78
Telmatochromis, 162
temnincki, Macrochelys, 234
Teretulus haydeni, 154
terrae-novae, Scoliodon, 246–247, 293

Terrapene
  carolina carolina, 280
  carolina triunguis, 278–279, 324
  major, 280
  ornata, 317
  ornata ornata, 278, 280
terrestris americanus, Bufo, 37, 98, 311
terrestris, Bufo, 210–211
terrestris charlesmithi, Bufo, 37–38, 85–89
Tetragonurus
  cuvieri, 53–54
Testudo, 164
  caretta, 141
  coriacea, 141
  imbricata, 141
  picta, 141
  serpentina, 141
texana, Cyprinella, 318
texanum, Ambystoma, 47, 109, 280
textilis, Musa, 144
teyahalee, Plethodon jordani, 95, 105
thalassinus, Microgobius, 157
Thalattosaurus, 70
Thamnophis, 91
  cyrtopsis, 93
  elegans vagrans, 309
  marcianus, 143
  marcianus nigrolateris, 143
  sirtalis fitchi, 309
  sirtalis parietalis, 309
thazard, Auxis, 243
thoburni, Xenomugil, 173, 174, 177–183
Thunnus alalunga, 242–243
  albacares, 242
  saliens, 239
tiburo, Sphyrna, 293
tigrinum, Ambystoma, 43, 109
tigrinum, Ambystoma tigrinum, 46
tigrinum melanostictum, Ambystoma, 308
tigris, Cnemidophorus, 228
tinctorius, Dendrobates, 77
tomcod, Microgadus, 156
torresi, Nothopsis, 255–257, 259, 261
tortugensis, Crotalus, 50
Trachemys, 70
Trachypterus cristatus, 56
  taenia, 56
transversus, Laminospondylus, 136, 138–139
triangulum, Lampropeltis doliata, 50, 310
tribulus, Prionotus tribulus, 157
Trichiurus, 59
trichroistius, Notropis, 187–191, 193
tricuspis, Gymnacanthus, 19
Triglops nybelini, 18, 20
  pingeli, 19
Trimetopon, 94
Trimorphodon vilkinsoni, 309
Trinectes maculatus, 13–15
Trionyx, 166
  spinifera, 232
tripes, Nealotus, 304
triseriata, Pseudacris, 89
triseriata, Pseudacris nigrita, 85–89, 311–312
triunguis, Terrapene carolina, 278–279, 324
Trogonophis, 28
Tropidodipsas carri, 111
truei montanus, Ascaphus, 308
tunicatus, Liparis, 19
turneri turneri, Lycodes, 19
turneri, Lycodes turneri, 19
Tylosaurus, 25
tynerensis, Eurycea, 43, 52

Typhlomolge, 41–43, 52–53
Typhlomolge rathbuni, 41, 52, 108
Typhlops, 26–28
  delalandi, 27,
  jamaicensis, 27–28,
  punctatus, 27
Typhlotriton, 52
  spelaeus, 108
tyrannus, Brevoortia, 14

Uma inornata, 148
undulata, Ameiva, 92
undulatus, Micropogon, 14
unionensis, Centropomus, 14
Uroconger, 234
Urotheca dumerilii, 77
Uta
  graciosa, 148
  mearnsi, 148
  stansburiana, 148
utahensis, Charina bottae, 309

vagrans, Thamnophis elegans, 309
Valamugil, 173
valenciennesi, Moxostoma, 154
valliceps, Bufo, 211
vandykei idahoensis, Plethodon, 147–148
Varanus, 22–25, 28
  monitor, 22–23, 25
  salvator, 22
variabilis, Sceloporus, 93
variolata, Salamandra, 140
vermiculatus, Esox, 67
versicolor, Calotes, 25
versicolor, Hyla, 37
versicolor, Hyla versicolor, 31–36, 88, 98
ventralis, Ophthalmochromis, 162
venulosa, Rana, 322
venustus, Notropis, 187–190, 192–193
verrucosa, Synanceja, 249
verrucosus, Allocyttus, 244–245
victoriae, Moxostoma, 154–155
vilkinsoni, Trimorphodon, 309
villosus Mallotus, 10, 12
virens, Pollachius, 246
viridus, Crotalus, 314
viridis, Crotalus viridis, 50, 310
viridis helleri, Crotalus, 50, 310
virgatipes, Rana, 31, 215–216
volans, Draco, 262, 264
vulpes, Albula, 156, 248

welshi, Otophidium, 244
whipplei, Notropis, 188–189, 191, 193
whippleianalostanus chloristius, Notropis, 318
wilderae, Eurycea bislineata, 44
woodhousei, Bufo, 143, 208–212
woodhousei microscaphus, Bufo, 212
woodhousei fowleri, Bufo, 31, 98
wrightorum, Storeria dekayi, 98

xaenurus, Notropis, 187–192
xanthurus, Leiostomus, 14–15
Xantusia vigilis, 165
Xenodermus, 260
Xenodexia ctenolepsis, 300
Xenodon, 92
Xenomugil, 173, 181, 183–184
  thoburni, 174, 173, 177–183
Xenopeltis, 24–25, 30
Xenopholis, 260
Xenosaurus, 21–23, 25, 27, 93
xenopterus, Cypselurus, 57
Xenotilapia, 162
Xiphactinus, 136
Xiphophorus
  helleri, 299
  maculatus, 299

yonahlossee, Plethodon, 106–107, 109

zonata, Hyla, 322
zonata, Seriola, 156

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

Officers

Honorary Presidents—JOHN TREADWELL NICHOLS (Ichthyology), American Museum of Natural History, New York 24, New York; HELEN T. GAIGE (Herpetology), 1211 Ferdon Road, Ann Arbor, Michigan.

President—EDWARD H. TAYLOR, Department of Zoology, University of Kansas, Lawrence, Kansas.

Vice-Presidents—(Conservation) LOREN P. WOODS, Chicago Natural History Museum, Chicago, Illinois; (Finance) JOHN C. MARR, Box 271, La Jolla, California; and (Membership) A. P. BLAIR, Department of Zoology, University of Tulsa, Tulsa, Oklahoma.

Treasurer—COLEMAN J. GOIN, Department of Biology, University of Florida, Gainesville, Florida.

Secretary—ARNOLD B. GROBMAN, Florida State Museum, Gainesville, Florida.

Publications Secretary—N. BAYARD GREEN, Biology Dept., Marshall College, Huntington 1, West Virginia.

Editors—Editor-in-Chief, FRED R. CAGLE, Department of Zoology, Tulane University, New Orleans, Louisiana; Book Review Editor, ERNEST E. WILLIAMS, Biological Laboratory, Harvard University, Cambridge, Massachusetts; and Index Editor, DAVID L. JAMESON, Department of Biology, San Diego, State College, San Diego, California.

Editorial Board—Ichthyology: REEVE M. BAILEY, ROLF L. BOLIN, DAVID DUNKLE, ROBERT W. HARRINGTON, JR., CARL L. HUBBS, ERNEST A. LACHNER, EDWARD M. NELSON, JOHN C. MARR, ROBERT R. MILLER, EDWARD C. RANEY. Herpetology: EDWIN H. COLBERT, D. DWIGHT DAVIS, WADE FOX, JR., NORMAN HARTWEG, L. M. KLAUBER, JAMES A. OLIVER, CLIFFORD H. POPE, GEORGE S. MYERS, CHARLES E. SHAW, ROBERT C. STEBBINS.

Officers of Western Division

President—FRANCES N. CLARK, California State Fisheries Laboratory, Terminal Island, California.

Vice-President—ANGUS M. WOODBURY, 248 University Street, Salt Lake City, Utah.

Secretary-Treasurer—LILLIAN DEMPSTER, California Academy of Sciences, San Francisco, California.

Officers of Southeastern Division

President—WILFRED T. NEILL, Ross Allen's Reptile Institute, Silver Springs, Florida.

Vice-President—JOSEPH R. BAILEY, Department of Zoology, Duke University, Durham, North Carolina.

Secretary-Treasurer—ELMER E. BROWN, Department of Biology, Davidson College, Davidson, North Carolina.

Honorary Foreign Members

L. F. DE BEAUFORT; L. D. BRONGERSMA; FERNANDO DE BUEN; PAUL CHABANAUD; J. GUIBÉ; WALTER HELLMICH; C. C. LIU; NICÉFORO MARIA; KIYOMATSU MATSUBARA; ROBERT MERTENS; H. W. PARKER; H. RENDAHL; GIUSEPPE SCORTECCI; J. L. B. SMITH; MALCOLM A. SMITH; A. N. SVETOVIDOV; A. VEDEL TÅNING; ETHELWYNN TREWAVAS; DAVID M. S. WATSON; G. F. DE WITTE.

Affiliations

The American Society of Ichthyologists and Herpetologists is a member of the American Institute of Biological Sciences and of the Division of Biology and Agriculture, National Research Council, and is an affiliate of the American Association for the Advancement of Science. An annual contribution is made to the publication of the Zoological Record.

Back numbers of COPEIA, as available, may be procured from Prof. N. B. Green, Biology Dept., Marshall College, Huntington, West Virginia. Prices will be furnished on application.

Subscription, $9.00 per annum, $2.50 a copy.

Dues to Society: foreign and student members $6.00 annually; regular members $8.00 annually; sustaining members $25.00 annually.

Life membership: $150.00 single payment.

Patrons: $1000.00 single payment.

All memberships include subscription to COPEIA.

Dues and subscriptions are payable to the Society, through the Secretary.

Members should notify the Secretary immediately of any changes in address.

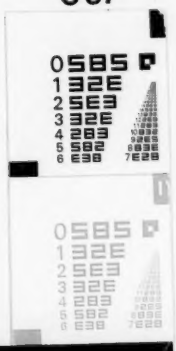
Manuscripts, news items, and all correspondence regarding the Journal should be addressed to the Editor.

Manuscripts should be submitted on good paper, as original typewritten copy, double-spaced, carefully corrected. Galley proof will be furnished authors.

Original contributions from members of the Society, not to be published elsewhere, are alone acceptable.

Reprints are furnished at approximate cost.

Figures, author's corrections, expensive tabular matter and unusually long articles may be charged in whole or in part to the author at the discretion of the Editor.

ΙΧΘΤΣ
ΒΑΤΡΑΧΟΣ
ΕΡΠΕΤΟΝ

C37